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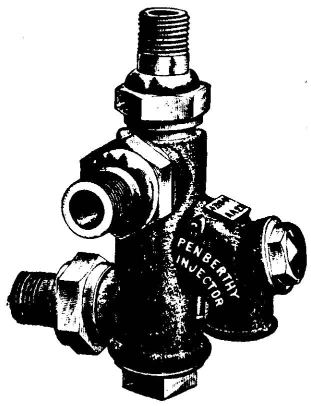

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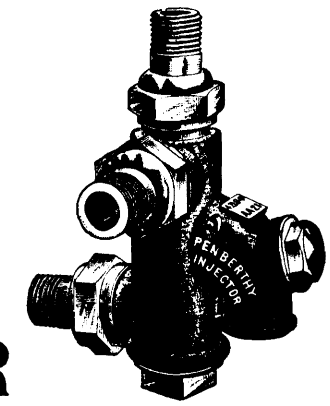

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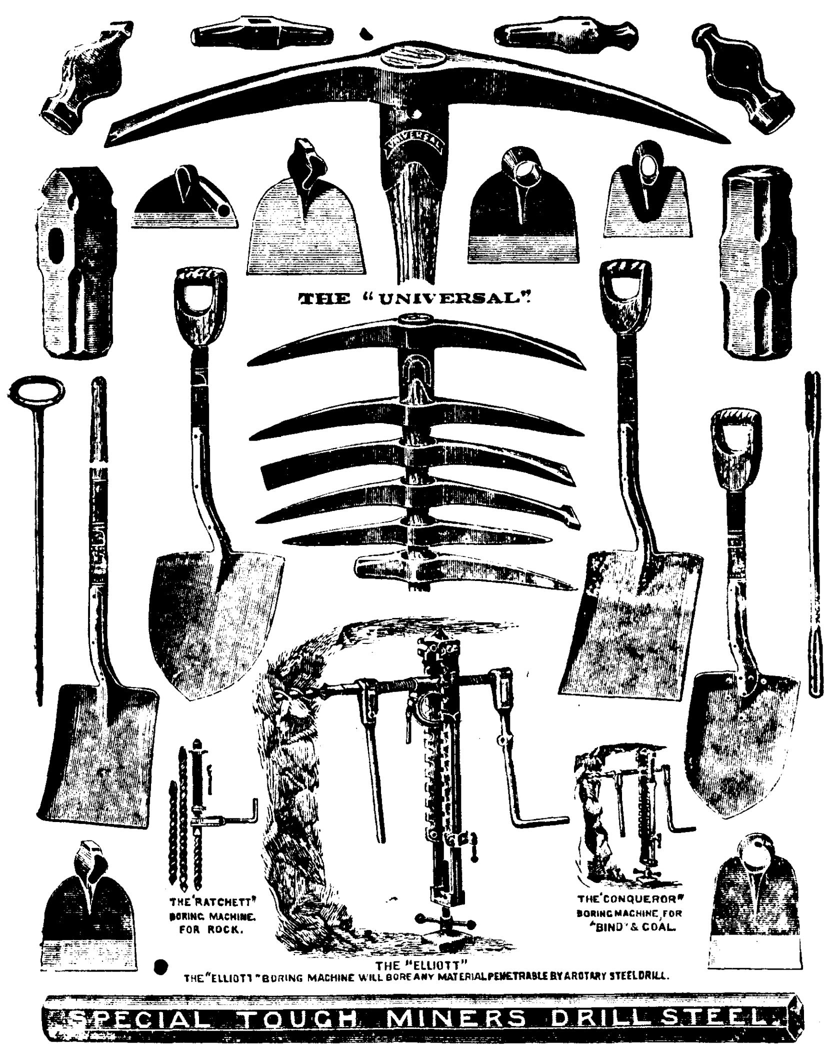

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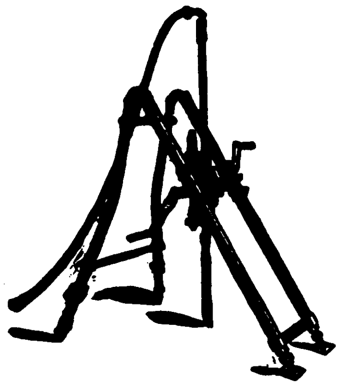

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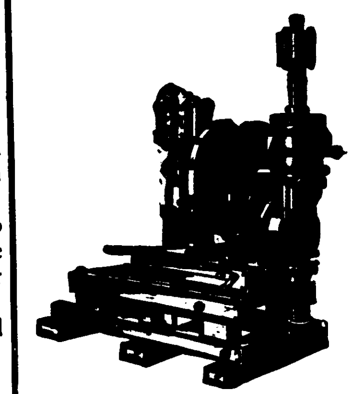

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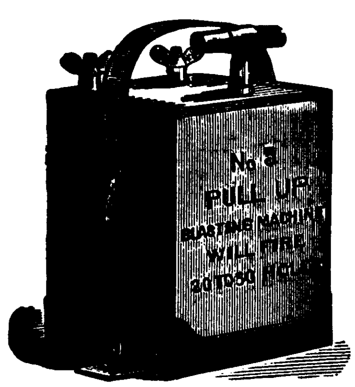

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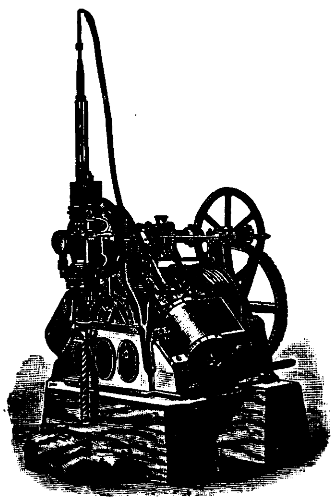

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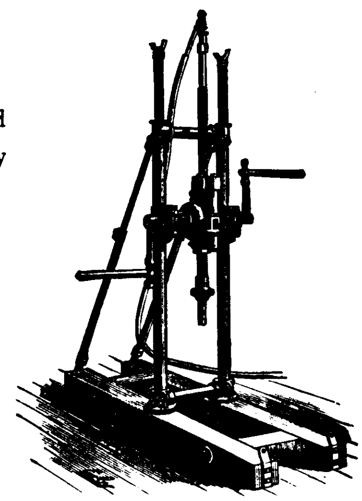

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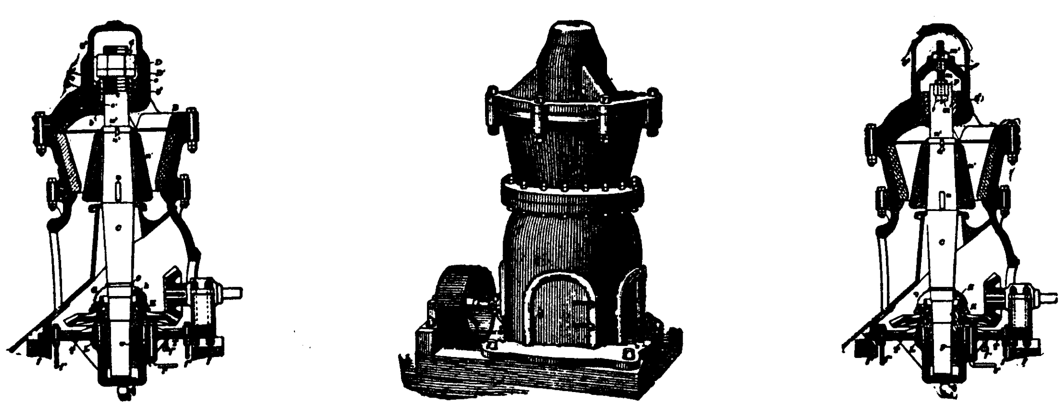

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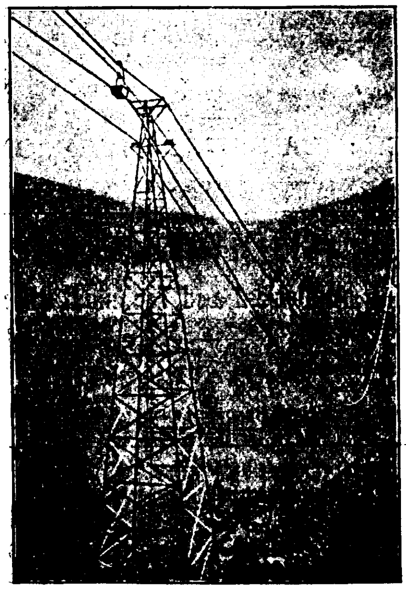

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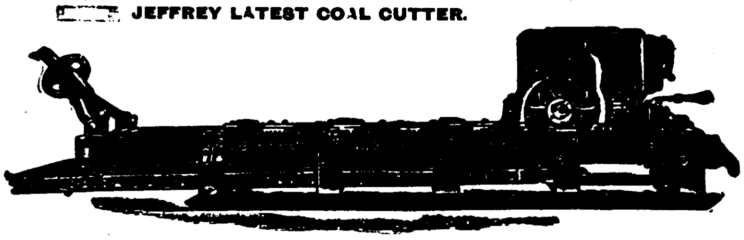

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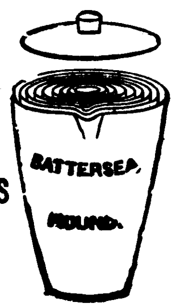

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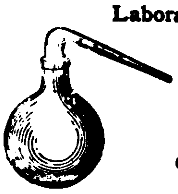

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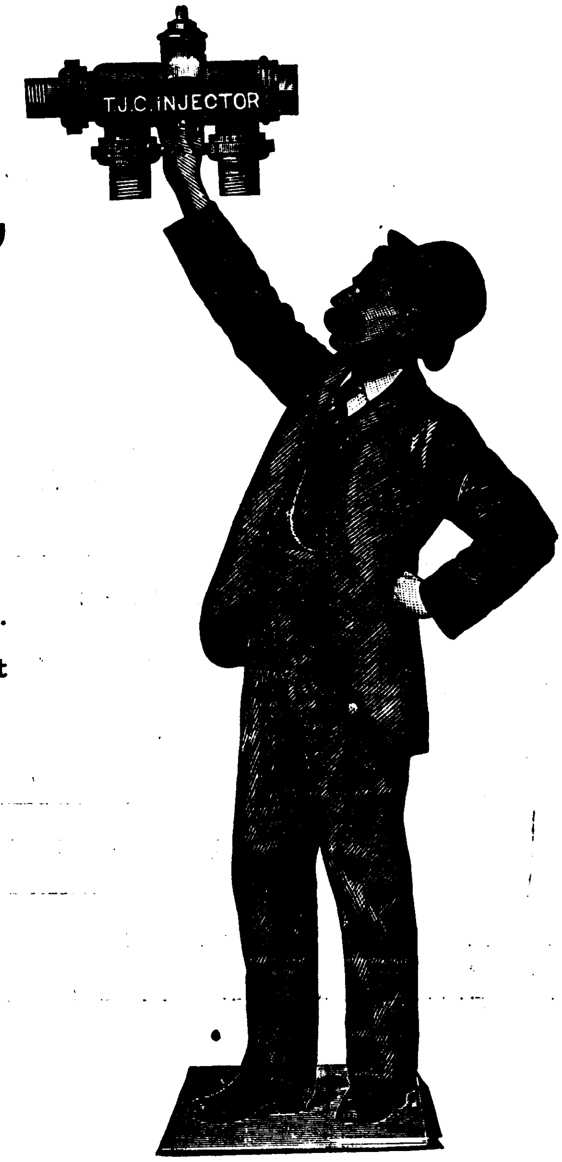

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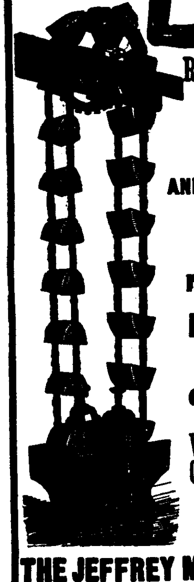

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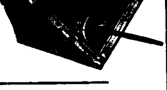

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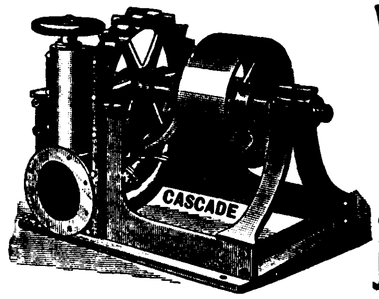

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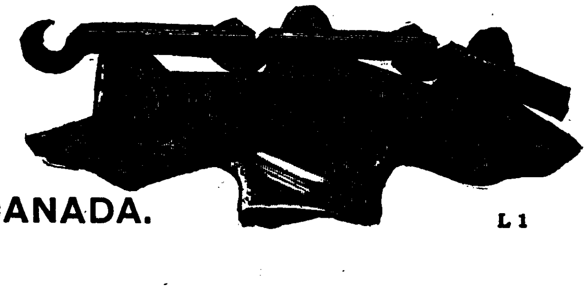

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VOL. XV., No. 6 JUNE, 1896. VOL. XV., No. 6

Quackery in Mining Education.

The article published in *The Engineering Magazine* for May on "Quackery in Engineering Education," has caused quite a tumult among the members of the various faculties of technical schools all over the United States and, as was to be expected, has called forth various and vigorous protests in the June number.

The subject and discussion is interesting and has its lessons for the engineering schools of Canada which have grown rapidly during the last decade, but which are yet in a formative stage.

In so far as the subject includes education in that branch of engineering which relates to mining and metallurgy the REVIEW desires to call attention to a few points that are emphasized.

The most frequent exhibitions of quackery, according to Professor Kidwell, (the author of the article alluded to) are (1) misrepresentation in catalogue or calendar as to what is actually accomplished in technical schools, (2) the necessary limitations of laboratory work, usually represented as complete, and (3) "the custom of allowing professors to con duct an engineering practice outside of their school duties."

Examining these points for a moment we find Prof. Kidwell's charge to be that "any catalogue statement which leads one to infer the school "possesses certain material when it does not, or that it is prepared to "teach properly certain branches when it really is not, is evidence of "quackery." Of this charge our Canadian technical schools may be absolved. Examination of the advertisements and catalogues of McGill, Toronto and Kingston does not show them offering what they do not give, although it does show a want of much that is desirable, nay necessary, to any student who is turned out into the world with a parchment certifying him to be a graduate mining engineer. The skeleton is there (except in the case of McGill, which defection is soon to be remedied) but the muscles are not all preseut, or if so, are paralyzed.

But this leads us directly to the second point, "the limitations of laboratory work," which in the original article are directed towards the shopwork and laboratory instruction of a mechanical engineering course.

Work by students in milling and metallurgical laboratories may be likened to that in mechanical shops, but must be judged differently.

As already stated above, two of our Canadian mining schools are supposed to be equipped with such a complement of milling machinery as to enable the student "to study the operations of crushing, amalgamating, concentrating, etc., on a large scale," while the third and largest technical school has "expectations" of an equipment in this direction—through the munificence of its great benefactor—which shall be adequate and equal to any facilities on the continent.

The equipments which have already been provided, as above, leave very much to be desired before a student can be properly instructed in the various processes, manipulations and reactions which milling and metallurgical work require; and though the public is promised much from the equipment McGill is to receive, it remains to be seen whether the fulfilment will realize the requirements of a practical engineer or be subsidiary to the *pure* rather than the *applied* science ideas of the governing powers.

In replying to Prof. Kidwell Mr. A. K. Landis makes the excellent point that it is absurd to grade a man as a mining engineer if he has never been down a mine nor felt the heat of a furnace. And while it can never be claimed that instruction in metallurgical laboratories will fit a man to take immediate charge of a copper, lead or iron furnace, it can nevertheless be maintained that such laboratory work fits a student to become more quickly a furnace-master and metallurgist than an equal student who has had no instruction in such a laboratory. Of course, from the nature of the subject, no laboratory work can help in *mining* instruction; *that* must be given by the summer school.

Instruction in properly equipped laboratories, where machines and quantities are *not* all full-sized, so as to make operations physically fatiguing to the students, and under the guidance of a professor who has had commercial experience in the treatment of ores, cannot fail to be a powerful factor in, and one of the most beneficial and lasting elements of the earnest student's professional education. Such laboratory work not only shows the student the necessity of judgment, but also teaches him his fallibility and tends to remove the "know-it-all" mental condition so characteristic of young graduates.

The last element of quackery mentioned is that no teacher should be permitted to continue his engineering practice outside of his college duties.

In this we do not hesitate to entirely disagree with Prof. Kidwell. Not only is it true that the vast majority of schools cannot afford to pay for the exclusive right to a competent man's services, but it is equally true that a man who is not in touch with the latest work in his profession, is unfit to teach that profession. Especially is this true in metallurgy and mining at the present time, when processes and practices in use today are superseded by improvements next year. To keep *au fait* with his profession requires more than reading alone will give.

Too much of the instruction now given in mining engineering subjects is ancient history. That stamps were formerly made of square wooden rods with iron-bound bosses, and that tappets were formerly pins, can well enough be read in later years when the student has earned time and leisure to read old text-books.

The modern course of four years is already crammed full with subjects not directly in the line of the student's future profession, often only two years out of the four being given to separate professional work after the general course.

To make a course (1) which shall embody the principles underlying the arts of mining and metallurgy, (2) which shall elucidate as far as possible the modern, present-day application of the principles, and (3) which shall present the business or commercial aspect of this combination of principles and practice, is, or should be, the aim of the mining professors in our technical schools. That there is a field in Canada for such a course never was more apparent than at the present time when American and English mining engineers are pouring into British Columbia and other provinces of the Dominion to develop and work Canadian mines. The raw material is here, the capital is here, the schools are here, and the students are here, and it will be the fault of our schools if, in the future, Canadian mining engineers are not able to cope with their foreign brothers in developing the Dominion's mineral resources.

EN PASSANT.

The attention of members is directed to the ensuing joint meeting of Canadian mining associations to be held under the auspices of the Mining Society of Nova Scotia at Halifax during the last week of next month Apart from the attractiveness ordinarily characteristic of the proceedings of the Mining Society, there is the Summer Carnival, for which elaborate preparations are being made, and which in itself should induce a large attendance from the Upper Provinces.

In view of this meeting the July issue of the REVIEW will be issued earlier than usual.

Forster ore and rock breakers and safety lamps of all kinds have recently been listed for free entry at the Department of Customs.

In a recent issue the REVIEW had something to say of a prospectus offering for sale certain shares of the Modstock Gold Mining Company. In this connection we are pleased to give prominence to the following excerpt from a letter sent to us by Mr. J. D. Copeland, the secretary of the company:— "I am pleased to be able to say that the Modstock Company is in no way responsible for the prospectus which you criticised so severely. In fact it is no more responsible for it than for the procession of the equinoxes, or for the vagaries of the individual who proposed to equalize the temperature of the globe by towing down the icebergs of the north and hanging them on the equinoctial line to dry."

Our next number will contain an elaborate descriptive article on the Rossland mining camp from the pen of our correspondent in that famous district of British Columbia. The value of this contribution will be enhanced by numerous illustrations.

The bill incorporating the Massachussetts Pipe Line Company—a company promoted by Mr. H. M. Whitney and associates of the Dominion Coal Co., has been favorably reported in the Lower House of the Massachussetts Legislature. It is proposed to erect a plant at Boston and other points in that State, which will not only furnish gas, but will also make coke and chemical by-products from Cape Breton coals The success of this enterprise means much for the extension of our eastern coal trade.

By recent order-in-council the regulation respecting the Dominion Government's bounty of two dollars per ton on pig iron has been amended so as to permit the bounty being paid on pig iron made partly from Canadian and partly from foreign ore This will be a boon to the Nova Scotia Steel Co. and the Hamilton Blast Furnace Co., both of which are using quantities of foreign ores in their furnaces.

We are pleased to notice that our anticipations of a good season in the Cape Breton coal trade are likely to be realized The season has opened up in fine style, both the General Mining Association and the Dominion Coal Company having shipped more coal in the month of May than in the corresponding month of any previous year. This is particularly gratifying in view of the fact that the latter company had not banked any coal and have thus been able to ship from the mine direct and in good condition. The total hoisting for the month reached 128,000 tons, and the shipping 111,000. Of this 24,000 tons were shipped at Louisburg and 70,000 at International pier. The second tower has just been erected at the latter point, as also a large pocket for bunkering, which will enable the company to bunker any vessel in less than an hour. The equipments at this pier are now complete and capable of loading 10,000 tons every 24 hours.

Some record hoisting has been done at the Dominion Coal Co.'s mines this month, Reserve reaching 1,684, and Caledonia 1,556 tons per day, while the aggregate hoisting for the week ending June 13th reached 45,000.

Our enterprising competitors in the States, not content with producing coal at a lower figure than any other country—thanks partly to the lavish bounty of nature, and partly to their own ingenuity and inventiveness—have just initiated a system, which, if it proves successful, will still further reduce the cost very considerably, and at the same time dispense with the most laborious process in connection with mining, *i.e.* the undercutting.

Of late years most of the developments in mechanical mining have been in the direction of producing new coal-cutting machines, by means of which, especially in Pennsylvania, large outputs have been obtained and the ultimate cost of cutting reduced some eight or twelve cents per ton, according to the nature of the seam. The latest development is to do without undercutting and shearing altogether, and by a more scientific system of boring and blasting than has hitherto been in vogue to achieve the same result.

The system has just been tried in one of the largest mines in Missouri, by the Madison Coal Mining Company, with every success, and the proprietors believe they can maintain their enormous output of some six thousand tons per day at a reduction in cost of at least six cents. Of course it should be borne in mind that this experiment was conducted in a specially favorable seam of coal, with a strong rock roof, smooth top parting, and soft clay bottom, which enables the coal to be brought down in large blocks, with very little small. At the same time we have no doubt that much more may be done by the judicious application of this system than has hitherto been effected by the obsolete and barbarous method of "plugging," so often resorted to with disastrous effects to the quality of the coal, while any system which reduces the proportion of arduous labor required to produce coal is a move in the right direction and will be hailed with delight.

The prizes offered by the General Mining Association of the Province of Quebec for the best paper on a mining subject contributed to its proceedings have been awarded to Mr. Raoul Green and Mr. W. Morton Webb, both of whom graduated this year at McGill. "Notes on the Eustis Mine," the paper by Mr. Green which was awarded the first prize of a value of $25 00, is reproduced in this issue. There were six competitors.

We are glad to learn that the retirement of Senator Mackeen from the management of the Dominion Coal Company's operations in Cape Breton, does not deprive them of his valuable services in another capacity. By electing him a director and appointing him second vice-president they will have the benefit of his counsel and experience as an advisory colleague, whilst his residence in Halifax will admit of his keeping thoroughly in touch with all that is transpiring in Cape Breton. In connection with this change the office of assistant manager has been abolished, and Mr. Wm. Blakemore, M.E., who has occupied the position for the last two years, has been appointed mining engineer to the company.

At a recent meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers Mr. R. S. Williamson (Cannock and Rugeley Colliery Company) read a paper on "Underground Haulage," in the course of which he alluded to the importance of efficient and economic haulage. He described, by a series of plans illustrating the

GENERAL MINING ASSOCIATION OF THE PROVINCE OF QUEBEC.

STUDENT PRIZE WINNERS, 1896.

MR. RAOUL GREEN, B.A. Sc. Winner of 1st Prize.

MR. W. MORTON WEBB, Winner of 2nd Prize.

New Mill of the Danville Asbestos and Slate Company, at Danville, Que.

motor plant and the hauling system employed throughout the Cannock Wood Pits, the Wimblebury mine, and the Pool pits, where, he said, the whole of the coal got had to be drawn by rope haulage to the bottom of the shaft. The output was equal to about 3,000 tons in the eight hours. The average speed was about eight miles an hour, as he believed in moderate speed and large loads rather than small loads and quick running. The average cost of labor on the "main and tail" roads was ·60 of a penny per ton, and in some instances it was as low as ·45. On the endless-rope system the cost worked out at ·66 per ton on the quantity at present dealt with, though the output could be considerably increased at no increased cost.

Professor Agassiz has recently been carrying out with great thoroughness and care some interesting experiments in underground temperature at the Calumet and Hecla mines. The *Mining Journal* remarks that the close bearing of the question upon deep level mining all over the world, but more especially in South Africa, lends considerable significance and interest to the results. The observations have been effected by means of slow-registering Negretti and Zambra thermometers, and have been taken at various depths, from 105 ft.—where the variations due to local changes of temperature may be taken to have ceased—down to 4,580 ft. The results, which differ materially from any previously recorded, are worth examination, and even study. At the various points in depth selected for investigation holes were drilled to a depth of 10 ft. below the face of the rock, the thermometer then inserted, and the borings subsequently plugged with clay. The deepest point at which an observation was recorded was at 4,580 ft., and here the temperature stood at 79° Fah., or 20° higher than at the 105 ft. station. "This," remarks Professor Agassiz, not altogether, perhaps, without some tinge of melancholy, "is very different from any recorded observations Lord Kelvin, if I am not mistaken, giving as the increase 1° Fahr for 51 ft., while results based on temperature observations of the St. Gothard tunnel gave an increase of 1° for every 60 ft." These results suggest the much more difficult problem of eliminating from the observations those modifications due to other causes than local changes in surface temperature.

It is reported that large deposits of asbestos of excellent quality have been discovered in Southern Montana, in the West Gallatin basin; and a company has been formed to work the claims. The asbestos is said to be nearly pure white in color and to be of long fibre.

A. Rubricius, an Austrian chemist, recommends a new method for the prevention or removal of boiler incrustation which has furnished remarkably good results since about 1 year that it has been in use at Anina and other localities in Austria-Hungary. To the feed-water there is added a mixture consisting of 90 per cent. of soluble chromates and 10 per cent. of soda. These salts transform the more or less soluble carbonates contained by the water into soluble chromates which settle in the shape of slime without adhering to the walls of the boiler and the latter can easily be cleaned by washing. The beneficial effect of the process will be felt even in the case of boilers which are already lined with thick layers of incrustation, for these will be gradually reduced and transformed into slime. On an average ⅛ of an ounce of the mixture should be added to 35 cubic ft. of water. For an ordinary boiler 3 to 4 ounces per day would be sufficient. Where water with very high lime contents is being used, the dose should be increased a little; the exact quantity needed can easily be determined by a preliminary test.

In selling a prospect or a mine nothing is gained and often everything is lost through misrepresentations as to its value. During the present season there will be a better market for undeveloped claims than ever before, but the owners cannot exercise too great a care in describing their properties to intending purchasers. If an investor finds, upon examining a mine, that misleading statements have been made, he is filled with disgust, and is inclined to break off all negotiations. The mine-owner's delusive expectations are often rudely shattered by the cold-blooded mathematics of the purchaser. He is frequently unable to sell because he has deceived himself as to the true market value of his property. It should always be borne in mind that investors who understand their business figure upon a safe and conservative basis, and are not inclined, as a rule, to pay for much more ore than is in sight. The owner may be certain that the ore body extends, in increasing richness, to indefinite depth, but the purchaser calculates upon a "pinch," or a "fault," and will not pay a very great sum for a mere surface showing. Hence it is of the utmost importance that the owners of prospects place them in the best possible shape, for every dollar spent in development often adds a thousand dollars to the value of the property.

Assay returns are most unsatisfactory evidence of the value of a discovery or of a mine. To say that a 4 ft. vein assays $1,000 per ton sounds big, but such information carries little weight with a purchaser. What he desires to know is the average milling value on the 100 level, the milling value on the 200 level, the extent of the ore body at various depths, character of the ore, with reference to treatment process, cost and profit on production and probable yield of the mine. Mine-owners do not always give careful consideration to these points in fixing the price upon their properties, but figure in the possibilities at half a million or so, and are unable to understand why they cannot find a purchaser.

Graphite, which is one of the forms of carbon, and more generally known as plumbago or black lead, has come to be an important factor in electrical industries. It is a graphite crucible which is used for electrical smelting, and it is a graphite pencil or rod which is used as an electrode in the process of electrical smelting. It is graphite pulverized to an impalpable powder that is used in electrolytic work by the copper smelters. Pure flake graphite is also used for lubricating cylinders and bearings of engines and dynamos, and the same material also forms the pigment for protective paints for trolley poles, electric light poles, and roofs of dynamo plants and trolley-car sheds. Graphite would therefore seem to be a very important factor in electrical industries.

Conservative mining men urge that it is time a halt were called in the formation of irresponsible mining stock companies. They say men who never saw a mine, who know nothing of mining methods, are lending their names to doubtful enterprises. Many have become feverish over stock speculation, and nothing can be done to prevent it. There are now over 3,000 mineral locations in the Trail Creek district alone, covering at least 125,000 acres. In each case the locator has sworn that he has mineral in place. This proposition is hardly tenable, unless the country is one big body of ore, and this is not possible.

A mining man said the other day that "any ground in Trail Creek could be sold; that the people were after acres not mines, the idea being to incorporate and sell out; that acres were as good for the purpose as mineral ground." He also said: "The forming of these really illegitimate companies was not for the purpose of working the ground, but for the purpose of mining the public." There is undoubtedly a large percentage of truth in this statement.

There is another thing which is working to the disadvantage of legitimate mining. Before treasury stock is exhausted, private stock is offered for sale, in many instances at a price far below that for which treasury stock can be purchased. As a consequence development is retarded, the treasury stock cannot be sold and the proposition, even though it be a meritorious one, falls into disrepute. The purchaser of the treasury stock is disgusted, feeling that he has been duped, and denounces mining.

Perhaps nothing can be devised to eliminate the evils which follow in the wake of successful mining. It is an old story. It has been repeated over and over again, from the early days of mining in California. It will probably be continued until the end of time, unless the people learn wisdom.

GOLD MILLING IN NOVA SCOTIA.

The following returns have been furnished since our last statement by courtesy of the Mines Department, Halifax.

Name of District.	Name of Mill or Company.	Month in which Crushing done and Returns made.	Quartz Crushed. No. of Tons.	Yield of Gold. Ozs.	Dwts.	Grs.	Total Yield. Ozs.	Dwts.	Grs.
Sherbrooke	Stellarton Gold Mining Co.	May	65	16	7	9			
"	New Glasgow Co.	May	316	130	0	0			
"	Crow's Nest Mill	April, May	125	36	0	0			
"	McNaughton Co.	May	18	6	5	0			
			524	188	12	9	188	12	9
Stormont	Richardson Gold Mining Co.	April	1835	215	0	0			
"	J. D. Copeland	April	265	189	19	0			
"	Jas. A. Fraser Mill	April, May	330	79	10	0			
			2430	484	9	0	484	9	0
Moose River and Cariboo	W. A. Sanders	March {Quartz, 308 tons. Slate, 382 "}	690	64	19	0			
" "	Moose River Gold Mining Co.	April, May	395	99	19	12			
			1085	164	18	12	164	18	12
Brookfield, Queen's County	W. L. Libbey *et al.*	May	478	565	0	0	565	0	0
Uniacke	J. J. Withrow *et al.*	May	200	129	0	0			
"	Golden Lode Mining Co.	March, April	54	473	6	15			
			254	602	6	15	602	6	15
Lake Catcha	John H. Anderson	April	10	10	0	0			
"	Oxford Mining Co.	February	466	23	6	6			
			476	33	6	6	33	6	6
Tangier	Essex Mill	January, February, March	401	43	17	0	43	17	0
Montagu	Hayward & Bell	May	57	45	17	18	45	17	18
Cow Bay	Thompson & Hill	June 8th	50	91	8	15	91	8	15
		Total					2219	16	3

At the last meeting of the Midland Institute of Mining Engineers, there was a discussion on Mr. Alexander Reid's paper on "Methods of Closing the Tops of Upcast Winding Shafts. Mr. Reid is in favor of a system whereby the ascending cage enters at the top of the shaft, a kind of wooden box having self-acting doors that close behind it, thereby avoiding any interference with the ventilation. One member said that where apparatus of this kind was employed, safety hooks were not used in some cases because it was said that the continued passage of the catch through a small space, rendered the catch liable to act before its time. Mr. Hargreaves and Mr. Routledge bore testimony to the value of the system advocated by Mr. Reid. They had had a similar system at work for several years, and they had never found the slightest difficulty or danger in connection with the safety-hook. The door for the hook and shackles was a light one which travelled up and down with the cage, not in any way interfering with or touching the hook. Mr. Hargreaves added that at another pit where the winding-shaft was used as an upcast, they had not this system at work; but the banking was done in an air-tight chamber away from the mouth of the pit, and this was found to be a very costly and troublesome arrangement.

The car-wheel industry is one of the most important in the United States, as well as one of not a little extent and value in Canada. It will, therefore, probably interest our readers to have the following facts as to the recent course of the American industry put before them by an American car-wheel maker:—

Notwithstanding the fact that Lake Superior charcoal pig-iron has advanced in price during the past year, from $4 to $5, the price of car-wheels has advanced very little, if at all. This is due to the fact that nowadays a very great proportion of the material going into ordinary car-wheels is not charcoal-iron at all, but foundry iron, or scrap of the poorest description mixed with ferro-manganese. The number of wheel makers who are using charcoal-iron exclusively in their wheels is very small indeed, and the competition induced by the material used as above has really brought the chilled-wheel business for some roads to a worse condition than it has ever been in before. At the present moment I know of a number of railroad companies who are buying wheels for considerably less than a cent a pound, and who would, without the slightest delay, change their business from makers who have supplied them for years if every concession in price made by competitive makers was not met by those who supply them. There are, of course, a number of railroads who are not doing their business on this principle; but so many of the large railroads are, that the average wheel-maker nowadays has very little money left to put into anything but the actual expenses of operation. It is, on the whole, a disappointing condition of affairs, for the railroads are certainly not profiting by the quality of wheels they are getting, and it will, of course, lead to another general tirade against the quality of chilled-wheels, such as we had a number of years ago, when practically the same conditions prevailed, although on a considerably higher range of prices.

The advent of the electric railroad has introduced new conditions for some wheel makers. The conditions of service are so different on roads of this class, as compared with steam railroads, that, while the competition in prices is growing more and more every day, still the matter stands in quite a different light. The electric railroad is solely concerned with the wheels it buys, and not with the wheels that other companies buy. The steam railroads, on the other hand, receive fully 50 per cent. of the wheels they pay for through the hands of other companies, who supply them under the Master Car Builders' rules; and, even if a steam railroad were disposed to buy a good quality of wheel, it would have to take the position of buying one quality for use under its own cars and another quality for the cars of other companies, and, as a rule, they will not do any such thing. Again, so many companies are willing to buy wheels at the lowest possible price, with the intention of making a little money on charging them out under the Master Car Builders rules, that the premium on poor material and workmanship is growing higher every day.

Nickel-steel has just been exhaustively tried in the German navy for the propeller blades of small craft, and the results, it is stated, have been satisfactory, particularly in respect of the absence of corrosion, which plays havoc with the screw propellers of torpedo-boat craft, owing to the blades being very thin. In the course of the experiments the common steel propeller fitted to one boat was found only after three months to be badly corroded, while the nickel-steel screw propeller was in good condition. Both boats were alike, and had been subjected to the same steaming tests. In another instance, however, where in one screw propeller two blades were of common steel and two of nickel-steel, all were found to be corroded after eight months' steaming, although the nickel-steel stood best. All, however, had to be renewed.

Mr. Wm. Blakemore, mining engineer to the Dominion Coal Company, contributes to the prroceedings of the North of England Institute of Mining and Mechanical Engineers an interesting paper on the subject of "Coal Cutting Machinery," in which he claims the following advantages:—

(1.) That in consequence of keen competition, and the necessity of increasing to the maximum capacity the output of mines, some mechanical means for cutting coal must be adopted in the near future.

(2.) That one or other of these machines can be used with advantage, both on the score of efficiency and economy, for the purpose of mining coal.

(3.) That it is possible to introduce the system into any well regulated-mine at present in operation, although it may not have been laid out originally with this intention.

(4.) That it is practicable to work one district of a mine on this system without adopting it for the whole of the mine, and without interfering with the other districts, but it is not economical to do so, unless the whole of the district can be given up to it.

(5.) That in the case of a new colliery just being opened, it is in the highest degree advisable, unless the conditions of the mine are exceedingly difficult (such as an abnormally bad roof and soft wet floor), to make provision in the first instance for the introduction of mining machinery.

(6.) That in the case of an exceptionally favorable mine with strong roof and floor, it would be the best policy to lay down the plant from the commencement with the view of working the whole of the output by machinery, and the larger the output required the greater the advantage of this system.

(7.) That while there is an undoubted saving in the actual cost of production, this is not the only, nor indeed the most apparent advantage. The author considers that in the opening up of a new mine it would pay to put down a small plant for the purpose of driving all the headings, even if it were taken out again, and not used for the ordinary mining of coal, so great a saving can be effected in the cost of this class of work, and also in the speed with which it can be performed. The writer has no data to guide him in this statement, but during his own experience of more than twenty years, the opening up and development of a new mine to a capacity of 1,000 tons per day within a year is without parallel, and this was effected at the Dominion No. 1 mine. Such a result must be accredited entirely to the use of mining machines.

(8.) A further advantage is the larger tonnage of coal which can be produced from a given area or length of working-face. This increase the writer estimates at double the production of hand-picks, and it is hard to calculate the extent of the saving in a large mine due to this fact. It means half the length of working-face, and probably not more than 75 per cent. of the roads and air-ways to be constructed and maintained for any given output.

(9.) There is a further advantage of a very material character in the fact that a so much larger output of coal can be secured with the same number of men, and there are times when under sudden stress of demand this becomes a very important matter, as it enables one to respond more promptly and without difficulty to a sudden demand, the elasticity of the system being much greater than is possible under the older methods.

(10.) The writer would also class with the advantages the fact that, whilst working at a price which is satisfactory to the employer, the machine operator can earn considerably more money than by the hand-picks. This soon popularizes the machine, and creates contented workmen. It is also a move in the direction of all modern mechanical substitutes for arduous and unnecessary manual labor, which ought soon to be as obsolete in a mine as it is in a well-equipped modern iron and steel works.

Of course, some of these advantages are not as apparent in a densely populated country with surplus labor generally at hand, but in a new country, or even in a new district, it would be impossible within a short time to collect sufficient men to open up and develop a large mine. We all know, under such circumstances, the experience of collecting men together a few at a time, and making what appears to be a snail-like progress, while capital is being expended and the mine is eating its head off with interest; and, under any circumstances, if there be a justification for opening up a new mine, there must be at least equally sufficient reason for opening it up as quickly as possible.

There are certain disadvantages that should be enumerated. Among these are the addition of a considerable sum to the capital outlay, and consequently the fact that in times of stagnation there is much more capital lying idle; the difficulty and opposition which has to be encountered in introducing a new method; the necessity for conducting the general operations of the mine upon a different system.

It must also not be forgotten that mining by machinery entails in some respects a great deal of additional worry and anxiety upon the managing staff. Nothing could be simpler than that a workman should carry his picks into the mine with him, or obtain them at some station, do his work, carry them out, and there is an end to the matter; but cutting by machinery means an almost daily lengthening of pipes in each working place, the keeping of a large array of hose and fittings in working condition, the sharpening and supply of the picks for machines, which, owing to the harder blow struck, are damaged or worn out much quicker than a hand-pick; the supply of duplicate parts, and doing of constant necessary repairs to the machines themselves. All these details involve much labor and attention, and unless the staff is thoroughly well organized and every detail carefully attended to satisfactory results cannot possibly be achieved. A successful result, however, as the members will observe, is entirely a matter of organization. There are no insuperable difficulties, and when once a mine has settled down to this system it is quite possible to run along smoothly and efficiently; in the introduction of the method, however, much trouble lies.

Balancing the advantages with the disadvantages, the writer has no hesitation in saying that the former largely predominate. Of course, these observations can have no reference to mines where, owing to the superincumbent pressure or texture of the seam, little or no undercutting is required; but so long as headings have to be driven and strong seams of coal have to be undercut and sheared, a machine will do this more efficiently and economically than a hand-pick.

In a paper entitled "The Recollections of a Blast Furnace Manager," at a recent meeting of the Siegen section of the German Society Engineers, by Herr Fritz W. Lürmann, the author commenced with 1834, the year of the introduction of railways into Germany, the development of the pig-iron industry being connected hand-in hand with the extension of the railway system. Even now pig iron plants are closely dependent on railways, seeing that while any fault in construction of the furnace can always be remedied, any errors as regards location of the works with respect to transport cannot be so easily removed. In many respects, prevailing ideas with regard to the construction of blast furnaces have been entirely reversed. In the early days, efforts were made to retain the heat in the furnace as much as possible by surrounding it with a thick wall, while now it is built in such a way that it may be kept as cool as possible. Again, while a cold-blast was formerly considered indispensable, so much stress is now laid on a hot-blast, that often more money is expended on the hot-blast plant than on the furnace itself. A large amount of power was required in the old days for the operation of a blast-furnace in obtaining the necessary air pressure for the manœuvring of the charge, etc., while now the power given off by the blast-furnace in the shape of waste gases, is employed in the firing of boilers for steam-raising purposes. In the early days the blowing-in of a furnace was an operation accompanied by a great waste of fuel, time and labor. Later the practice was to fill the furnace with coke, and during the reduction process to throw in certain ores as would bring down the ashes and the slag. It was not until after many years that small charges were discontinued in favor of larger ones, the charge being increased until a desired point was attained. The author then quoted from his own experience as to the immense difficulty in getting rid of the "vorherd," or forepart of the hearth of the old type of furnace, owing to the opposition of the workmen, especially the old "smelting masters." The difficulty was only got over by replacing the practical workmen and training up men who had no experience and no opinions in connection with blast-furnace practice. The author held that the old forepart of the hearth, in the case of a steady-going furnace, only increased the repair bill, while in the case of a bad furnace it was not required. He next related how poorly his proposal was received in the Westphalian district that lime should be added to the furnace, and that coal should be washed before being turned into coke. The author then dwelt with the question of transport at the furnaces. He considers that more attention should be paid to the reduction of cost in the loading of the furnace-charging wagons direct from the railway wagons. At several plants, by attention to this detail, the cost of loading and manœuvring of the charging wagons has been reduced from about 1¾d. to ½d. per ton, this economy having regard to the total weight dealt with, representing a large saving in the course of a year. In England this point had received great attention, owing to the high cost of labor, and mechanical plants had been adopted wherever it was possible to do so in place of hand labor.

In order to avoid the dangers of electric sparks and of the flame of the explosive, quicklime cartridges have repeatedly been suggested and applied with a certain amount of success. They cannot, however, replace the powerful, instantaneously acting explosives. Mr. Ludwig Jaroljmek, of Prague, has had the idea of combining quicklime and dynamite cartridges in such a manner that the quicklime by absorbing water heats a preliminary primer sufficiently to fire off the detonator which is imbedded in the dynamite. Two commissions, the Ostrau Fire-damp Commission and the Rossitz-Oslava Commission, have reported favorably on the new cartridges, which Mr. Jaroljmek has perfected in conjunction with two Prague firms, Messrs. Sellier and Bellot and Mr. A. Schram. Tests were conducted in the collieries of the Emperor Ferdinand North Railway, at Polish Ostrau, in May and June of last year. An abstract of the reports is given by the inventor in the issues of November 16th and 23rd of the *Oesterreichische Zeitschrift fur Berg and Huttenwesen.* We quote those reports:— "The quicklime is applied in the shape of cylindrical blocks, ending in truncated cones. Into a hollow in the block fits a two-part capsule. The part which is surrounded by the quicklime contains a preparation which takes fire at 212° or 230° Fahr.; the other part, which reaches into the dynamite, is charged with a detonator. When the lime is slacked, the temperature may rise to 750° Fahr. The parts are not put together before everything is ready. The compound cartridge is then inserted in a bag of loose cotton, knitted like a stocking or woven like a wick. A little wire is twisted round the open end of the bag, and the ends of the wire are bent back. These wires prevent the cartridge from slipping out of a hole bored in an upward direction. When the hole is inclined downward, water is simply poured into it over the cartridge just fixed in position. When this is not possible, either special water bags of cartridge shape, made of a stoutish porous paper, are applied and fixed by a tamping, or the lower part of the whole is filled with moss soaked in water. This latter expedient stood all the tests. The blocks are made in different sizes, and are partly encased in tinfoil. The part to which the water is to have access is provided with a removable cap of tinfoil to keep off moisture and the carbonic acid of the atmosphere. The dimensions of a complete cartridge would be, for instance: Total length, 3·5 in.; diameter, 1·2 in.; length of dynamite cartridge, 2 in.; of lime block, 1·5 in.; of primer capsule, 0·75 in.; diameter of capsule, 0·3 in. The tests were made under considerably varying conditions and with different kinds of explosives, not safety explosives. There were no failures, and, on the whole, firing ensued within the periods stated by the manufacturers. No case of premature firing is reported. Small naked cartridges went off in half a minute or a minute; the same blocks, more or less heated, in one or two minutes, according to the looseness of the bag. The Ostrau Fire-damp Commission worked in an experimental gallery, which contained 6.8% of methane and an ample supply of coal-dust, which was kept in agitation. In no case did the cartridge fire the gases or the dust. The commission declare that evidently the explosion cannot spread, and that hence this method is safer than electric blasting, in which sparks must always be feared. The flame is confined to the interior of the cartridge, and is stopped both by the slacked lime and by the water in the bore-hole."

The *Vereinigte Koln-Rottweiler Pulver Fabriken* once more advocates a nitrate of ammonia powder as a safe blasting explosive. That such powders are powerful is acknowledged. The trouble is to keep the moisture off the hygroscopic nitrate of ammonia. The inventors hope to attain this and other objects by mixing the nitrate with oil in peculiar machinery of their own. One part of oil is reckoned upon twenty of the salt. Several oils will do—cotton oil, linseed, or rapeseed are employed by preference. But more or less solid fats, palm oil, etc., may be utilized, provided they can be liquified during the process without applying heat from the outside. The ingredients are first mixed by hand; they are then reduced to a fine flour, and finally to real dust; the mass becomes quite dry. In this state it is treated like black powder, grained, and dried slowly, or pressed into cakes. Fulminate of mercury serves as a primer. Neither poisonous gases, nor glowing particles are given off. Other nitrate of ammonia compounds have been prepared with petroleum and also with rosin. Some of these are too difficult to ignite; and when heat is applied to melt the rosin, the mass loses its homogeneous character.

Mr. F. W. Hardwick, Professor of Mining at Firth College, Sheffield, delivered lately one of a series of lectures arranged by the Midland Counties Branch of the National Association of Colliery Managers, in connection with the Technical Education Committees of the Notts. and Derbyshire County Councils. The subject dealt with was the washing of fine coal and slack, and the lecture was given for the benefit and encouragement of colliery managers, under-managers, deputies, and all engaged in mining. At the outset the lecturer stated that the subject was beginning to attract a good deal of attention, owing partly to competition in the coal trade and to the increased demand for greater purity of all classes of coal. There were, he pointed out, two sets of impurities mixed with the coal—chemical and mechanical—the latter of which it was impossible to separate except by some mechanical means. These means depended—firstly, upon the specific gravity of the substance treated; and secondly, on the sizes of particles which made up the whole of the mass treated. For this reason it was necessary that the classification of the coal and dirt into sizes should precede the treatment by which the dirt and the coal were separated. The lecturer then divided the various systems of separation by water into three classes. firstly by machinery, which effected the separation by a stream of water flowing down an inclined plane; secondly, by means of a continuous descending current; and thirdly, by the action of an intermittent current, the washing being performed on the jig. These systems were fully described and illustrated by means of lantern slides, and Mr. Hardwick concluded by giving a somewhat detailed description of the Lührig and Baum systems of coal washing.

An exchange gives the following definitions of mining terms for the benefit of the "tenderfoot:"

Ore—Sometimes spelled oar; sometimes a rich syndicate will stick in when a poor man is about to patent a good claim.

Lode—More properly spelled load; something a prospector carries around town with him when he sells out a hole for $1,000, more or less.

Vein or Vain—The hopes of the tenderfoot when he goes around breaking up building stone and looking for twenty-dollar gold-pieces on the inside.

Whim—The peculiar inclination sometimes felt by a miner to rest when the foreman is somewhere else.

Windlass—The condition of a man after falling down a 50-foot shaft.

Contact—A cont act is a touch, and a touch is what the tenderfoot makes on the homefolk when he learns that mining means work.

Air Drill—The homeward journey of the busted tenderfoot on a menu composed chiefly of atmosphere.

Lead—Something each miner wants when the whistle blows to quit work.

A True Fissure—The mining broker who lives by catching suckers.

Country Rock or Old Country Rock—The shamrock.

A new concentrator is the invention of John O. Norbom, and manufactured by the Joshua Hendy Machine Works of San Francisco. The machine is an endless-belt vanner, built entirely of iron, the shaking frame or belt-carrying table made of channel irons; the eccentrics on the driving shaft are adjustable so that the table can be given different strokes, the 1-in. and 1½-in. being mostly used. Either a canvas or rubber belt, according to the character of the ore, is employed. There are devices for adjusting the grade of the table as well as for adjusting the belt speed. The device that gives the table its motion consists of four curved steel springs, upon which the shaking-frame rests. Two of these springs are placed on each side of the machine, curved or bent in opposite directions. The driving-shaft lies on one side, and the eccentrics on this shaft, while giving a side motion to the table, cause the two springs on one side to bend down while the opposite springs straighten up, and *vice versa*, thus giving a peculiar gentle, side-tilting motion to the table. The longer the stroke, the greater the tilting. On a very short stroke the tilting or dipping of the sides of the table is very small. The machine can be worked on two different principles, viz., rubber belt, quick side-shaking motion with little tilting and short stroke; canvas belt, slow side-tilting motion and a long stroke. The manufacturers claim that this adjustability makes the machine suitable for almost any kind of concentrating gold ore, because operated on two principles of motion—either one of which concentrator manufacturers have always strived to attain—obviating the tendency of the pulp to pile up heavy and thick on the side of the belts along the edges, which reduces the effective surface of the belt and causes a loss of sulphurets that never could be separated from the gangue where the pulp was lying thick and dead. Where there is too much dripping of the edges of the table, the pulp would pile up heavy and thick in the centre of the belt. It is claimed for this machine that the gentle tilting given by the curved springs overcomes the tendency of throwing the pulp to the sides, though not sufficiently strong to throw it to the centre, and that the pulp is evenly distributed the full width of the belt, thus increasing the working capacity and close saving of sulphurets While the machine takes care of the pulp from five stamps with ease, in one instance it is now taking the pulp from ten stamps, the ore carrying from 4 to 6 per cent. of sulphurets. Mechanically, it is a substantial and durable machine. The canvas belt employed is made from heavy special-made duck. The belt has round edges, obtained by wrapping the canvas around rubber hose. The edges work in grooves on the end of the rollers, thus holding the belt in its place and preventing it from working sideways; the edges are protected so as not to be cut by the rollers. The machine is intended to meet the demand for a concentrator that can be adjusted in the mill to suit the character of the material treated, thereby avoiding the expense and inconvenience of putting up and trying two or three different makes to ascertain which motion gives the best result.

In his report to the Commissioner of Northwest Mounted Police, Inspector Constantine, who is in command of a detachment in the Upper Yukon country, N.W.T., writes as follows respecting mining operations in that far off section of the Dominion:— "The country is full of quartz ledges, more or less valuable, and only requires a short way of getting in from the south, with the assurance of a certainty of supplies, in order to develop them. This is the reason that the south-east part of the country and upper river and lakes have not been worked. In a country where a man has to pole up a rapid river for some hundreds of miles in summer, then pack his food, clothing, camping and working tools on his back; or in winter, either haul them himself or with dog; consideration as to where he can get his food and clothing is of vital importance to him, and he is governed accordingly. This accounts for the number of men working on the 40-Mile and creeks emptying into it. Even here food has to be packed on men's backs in the summer at a charge of 30 cents per pound, and in winter by dogs at 10 cts. per lb. This is for about 85 miles. The outlook for the coming year is more promising than that of last year. A conservative estimate of the amount of gold taken out last summer and winter is about $250,000, and from the present outlook it should be increased by 50 per cent. A great deal will depend on Glacier creek which was worked for the first time last summer. Very little was done on account of the claims not being in proper shape for working. Many of the claims are quite deep and will pay better to work by drifting during the winter, which has been hindered up to the present by the mild weather. The work done so far has shown up a large yield of gold. There is still a little "snipping," *i. e.* working old bars on 40-Mile creek, but it does not pay much. There are a great number of creeks which have never been prospected, which undoubtedly would pay good wages if properly worked, and which will be before long. In fact there is hardly a creek within 300 miles south-east or north-west of here in which more or less gold is not found. The true value of the mineral wealth of this part of the country will not be known for many years to come, as new discoveries are being made each season. There will be a great deal of drifting done on Miller creek this winter. This creek has been worked for the past four years, and up to the present time has been the richest one here, and is good for some time to come. On claim 3 below "Discovery," there has been taken out in the last three years $55,000 in 500 feet of ground. This has been the best paying claim. Davies and Poker gulches are each good for a limited number of men. There has not been taken from these gulches any large fortune, but they have yielded good steady profit to the owners. Franklin gulch, one of the first discovered, is still paying well, and has been worked for the past nine years. About 200 men are working on Glacier creek, of which number two-thirds are working for wages. On Miller creek, about 150, of which 100 are working for wages. The lower ends of these two creeks are supposed to be in the Northwest Territories. Brown creek has been worked this winter. Bear creek and Clinton creek on the west side of the Yukon are gold bearing and in the Dominion. Gold has also been found on Indian creek, Squaw creek and other small streams flowing into Yukon from the eastward."

During the year 1895 British Columbia produced gold of the value of $636,545; which, with the exception of $135,000 from the quartz mines at Fairview and Camp McKinney, was derived from placer mining. In addition to this $2,175,000 were derived from gold and silver mining in the Kootenay district. These amounts will be substantially increased during the present season.

Exploring with the Govt. Diamond Drill.

By Thos. W. Gibson, Bureau of Mines, Toronto.

(Continued.)

Where the object of drilling is to determine the presence and situation of bodies of ore, it is essential that a record of the borings should be systematically kept. For this purpose the cores as they are brought up should be carefully laid away for reference and examination, which is usually done by placing them in shallow boxes not exceeding in depth the diameter of the core, a foot or so in width and 8 or 10 ft. long. The various sections of the core should be divided from one another by longitudinal strips of wood, and should be labelled with the number of the hole and depth from which they are taken. The drill manager should also keep a daily record of the work done by the drill, and note all items of interest, causes of delay, etc., from which he should make daily or weekly reports of progress to his employers.

A curious fact in connection with diamond drill holes is that they tend to vary from the direction in which they are begun. Vertical holes are liable to take a spiral course, due probably to the fact that there is a natural inclination on the part of the suspended rod to describe an eccentric curve with the free end at the bottom of the hole. Inclined and horizontal holes will also be deflected more or less, according to the nature of the ground and the condition of the boring tools. A case was noted at one of the Cliff shafts in Ishpeming, Mich., where a vertically-started hole at a depth of about 400 ft. was some 15 or 20 ft. out of plumb. At the Scotchman's United mine, Victoria, a diamond drill hole 370 ft. deep was deflected 37 ft. 3 in. At the Oriental Company's mine a hole 425 ft. deep was 60 ft. 9 in. out of its proper course. Nine holes were drilled in Michigan by Mr. Channing, the writer mentioned above, at angles varying from 15 to 60 degrees from the horizontal, and the variations at the bottom were from 11½ to 42 degrees. It was invariably found that this variation was in the line of flattening. Captain Peter Pascoe, of the Republic iron mine, reported that in his mine "horizontal holes invariably raised as they gained in length." The rods and core barrel lie on the lower side of the hole, while the bit fills the end. This causes the line of boring at any period to make an angle with the axis of the hole in which the tool is rotating, thus making the line of advance an upward curve. In estimating the results of boring by the diamond drill, this deflection should be taken into account.

The cost of work with the diamond drill depends to a very large extent upon the nature of the rock strata being penetrated, being greater in dense and broken and less in the softer and more compact rocks. Distance from means of communication and transport is also an item of importance. It frequently happens that operations are carried on in some remote spot where the roads are bad and where supplies of any kind are hard to get. Under such circumstances, the cost is somewhat increased, both on account of the difficulty in hauling in the plant, and the necessity for starting a camp for the accommodation of the men engaged on the drill.

In 1894 the Legislature of Ontario passed an Act relating to Mines and Mining Lands, which provided among other things for the purchase by the Government of two diamond drills to be used in the exploratory drilling of ores or minerals in the Province, and in the same session the sum of $15,000 was appropriated to carry out the provisions of the Act. Only one drill has yet been bought, the preference being given after careful investigation to the machine manufactured by the Sullivan Machine Company, of Claremont, N.H., and Chicago. A drill of the "C" class made by this company was purchased in August, 1894, at a cost, including certain extra equipment, of $3,760. A 15 h. p. boiler mounted on wheels, and a duplex pump, both of Canadian manufacture, together with the customs duty paid on the drill, brought the total cost of the outfit up to $4,275. By the tariff law of Canada, diamond drills for mining purposes are admitted free, but the operation of a law depends a good deal upon the interpretation of it. The view was taken by the customs authorities at Toronto that the diamond drill—and consequently the only part of the machine entitled to free admission—was the bit in which the diamonds are set, a circular piece of steel perhaps a pound and a half or two pounds in weight. All other portions, including the framework, gearing, pulleys, etc., were classed as "motive power," and so chargeable with a duty of 15 to 35 per cent. ad valorem, amounting to $350.41 in all. Duty on this basis had to be paid before the drill could be released from bond. On reconsideration of the matter, however, the department at Ottawa refunded $230.90 of the amount, leaving the net duty on the machine $119.51. The drill has a capacity to bore 1,200 to 1,500 ft. in depth, and takes out a core 1⅛ in. in diameter. It has proven itself a serviceable and satisfactory machine. Certain parts, such as bits, core lifters, etc., are subject to severe wear and tear, and frequently require to be replaced, but as duplicates can be quickly procured from the company's works at Chicago, where they are kept constantly in stock, no delay or interruption of the work need arise from this cause.

The regulations governing the control and management of the drill, as approved by His Honor the Lieutenant-Governor in Council, September 15th, 1894, and amended by Order in Council April 9, 1896, provide that it may be supplied to owners of mineral property or others desiring its services, upon their furnishing a bond for payment of the costs and charges of working it, including freight, fuel, labor, etc. In order, however, to encourage the opening up of properties by means of the drill, the Bureau of Mines undertakes to bear 45 per cent. of these charges in 1896 and 1897, leaving the party employing the drill to pay the remainder or 55 per cent. only. In 1894 and 1895 the proportion payable by the Bureau was 50 per cent., and from 1898 to 1900 inclusive it will be 35 per cent The Government supplies a mechanical manager of the drill and a fireman, the former being paid at the rate of $1,000 per annum while the drill is at work, and the latter $500. The only additional labor required is the help of a workingman to cut wood, assist in moving the drill, etc. The present manager is an experienced drill operator and miner, and quite capable of selecting the sites for borings on any location, but the practice hitherto pursued, which is the most satisfactory to both parties, is for the owner of the property to employ an engineer or expert to consult and advise with the manager in the location of the holes, the angle at which they should be bored, etc. It is easily seen that the successful and economic defining of a vein or body of ore depends very largely upon the judicious choice of sites for the borings, the inclination at which they should be made, and the depth to which they should be carried. In deciding upon these points, the skill and experience of the trained miner are most valuable, but they lose nothing of their worth by being reinforced by the conclusions of a scientific mineralogist carefully formed upon the spot. An extra charge of $50 per month is provided for when the services of the drill are retained after the property has been shown by means of the drill to be a valuable mineral property. The cores are not to be exhibited to any unauthorized person, nor information acquired during the working imparted to any one not entitled to receive the same.

The first property on which the diamond drill was employed was the Glendower iron mine, situated on lot 6 in the second and third concessions of the township of Bedford, in the County of Frontenac, on the shore of Thirty Island lake, and is connected with the Kingston and Pembroke Railway by a spur about four miles in length. It is the property of Mr. Joseph Bawden, barrister, and Messrs. Folger Bros., of Kingston. The ore body where exposed has a width of about 20 ft. It occurs in metamorphic rocks which have a strike about north-east and south-west and dip at an angle of over 80 degrees. The rock on the upper side of the deposit is crystalline limestone, while that on the lower has been described as hornblende schist. The ore itself is a coarse magnetite, and in places is well crystallized and shows a well-defined parting. Mixed with the ore there is considerable hornblende in large pieces. The mine was opened in 1873, and about 12,000 tons of good ore were raised and taken to the United States. Operations were then suspended, but were afterwards resumed by another company, and carried on upon an extensive scale for four or five years. It is estimated that about 75,000 tons of ore in all were taken out of the mine. At a depth of about 180 feet considerable sulphur was encountered in the ore, and work was discontinued. Some drilling was done, 300 or 400 feet in all, and it is said that good ore was again obtained. The object of the work undertaken by means of the Government drill was to test the correctness of this statement, and to ascertain whether the quality of the ore in the lower portions of the deposit was good enough to warrant the re-opening of the mine.

Work was begun with the drill on 10th November, 1894, at a point about 75 feet south of the old workings, the hole looking to the west and being pitched at an angle of 80 degrees. Crystalline limestone, hornblende, granite and quartz were successively pierced to a depth of 182 feet 6 inches, when the large drift from the old shaft was struck and the hole abandoned. For the second prospect, the drill was removed to a distance of 100 feet west of the shaft, and the hole was bored at an angle of 75 degrees pointing to the southeast. The depth reached was 702 feet, but as the angle of dip of the vein nearly coincided with that of the boring and was in the same direction, the ore body was not struck. The drill was then placed 213 feet south of the main shaft and 100 feet east of the ore formation, the hole being drilled at an angle of 70 degrees pointing to the north. At a distance of 197 feet from the surface the ore formation was struck and drilled through for 83 feet. The fourth hole was put down on the same site, the angle being changed to 78 degrees, but in the same direction as the last. At a depth of 270 feet the ore formation was struck and drilled through for a distance of 175 feet. For No. 5 prospect, the drill was kept in the same place, but turned about 10 degrees more to the northwest. The hole was bored at the same angle and in the same direction as the last, and the ore body was again encountered at a depth of 295 feet. It was cut clean across, and the hole finished at a depth of 450 feet. The drill was now moved 171 feet south from the site of prospect No. 5 and 100 feet east of the vein. The hole was drilled at an angle of 85 degrees, and limestone was chiefly gone through for a distance of 425 feet when the ore body was struck. This hole was finished in quartz on 17th June, 1895, at a depth of 525 feet. The aggregate depth of the six borings was 2,626½ feet, and the time consumed was 180 days of actual boring, or at the rate of 14½ feet per day. The rock formations pierced were limestone and granite, with bands of hornblende and quartz. In some places the strata were found to be more or less broken up and obstructive to the drill, but on the whole the ground, especially the limestone, was easily drilled through, and good progress was made, the drill frequently going as much as 30 feet in a day.

The result of the operations was to show that a very considerable body of good ore existed between masses of mixed ore.

The total cost of the work was $2,591.18, or $0.986 per foot of boring. The various items of expense were as follows :—

	Total Cost.	Cost per foot.
Freight	$63.58	$0 024
Lumber, hardware and other supplies	162.24	0.061
Wood	308.07	0.117
Teaming and labor	393 72	0.150
Repairs and renewals	81.95	0.031
Diamonds	494.34	0.188
Fireman	354.72	0 135
Superintendence	732.56	0.278
Total	$2,591.18	$0.986

The cost was divided between the Bureau of Mines and the owners of the property in the proportions provided for by the regulations. The total weight of diamonds used was 28.428 carats, worth as stated above, $494 34.

After work was concluded at the Glendower mine, the drill was removed to lot number 2 in the 2nd concession of the township of Maclennan, near lake Wahnapitae, the property of the Bonanza Nickel Mining Company, where a white quartz vein of great width had been discovered, which, though carrying no visible gold, had shown by assays a value of as high as $100 per ton. The drill wa got to the location with some difficulty, owing to the rough country through which it had to be taken from the railway station, and was placed about 70 feet from the foot wall side of the vein, the first hole being made at an angle pointing 60 degrees to the south. The conditions were found to be very different from those at Glendower. The hardest kind of granite was encountered for a distance of 138 feet, when the quartz was struck and drilled through a distance of 65 feet, the hole ending in the hanging wall at a total depth of 205 feet. The second prospect was located on the line of the vein 350 feet away from the first, the drill being placed 38 feet south of the foot wall, and the hole pitched at an angle of 78 degrees pointing to the north. The drilling was begun in quartz and ended in granite at a depth of 91 feet. The quartz, granite and syenite penetrated by the drill afforded the most difficult sort of boring. The rate of progress was consequently slow, and the cost per foot between four and five times as high as at the Glendower mine. The loss in weight of diamonds was 23.070 carats, and the cost of this item per foot of boring was upwards of seven times as great as at Glendower, showing conclusively the obdurate nature of the strata pierced. Following is a statement in detail of the cost of work :—

	Total Cost.	Cost per foot.
Freight	$ 66.70	$0 225
Labor and teaming	109.87	0.371
Wood	111.82	0.377
Lumber and drill supplies	43.00	0.145
Renewals and repairs	118 35	0.400
Diamonds	403.72	1.363
Fireman	141.49	0.477
Superintendence	284.47	0.961
Total	$1,279.42	$4.322

The drill was at work on this property from 5th August to 23rd October, 1895, 69 working days in all, the average rate of progress per day being 4 ft. 3 in.

Combining the operations of the drill at both places it is found that a total depth of 2,922½ ft. in eight holes has been bored by the machine since it was placed in the field, in 249 days actual work, at an aggregate cost of $3,870.60, or $1.324 per foot.

Following are the items of cost :—

	Total Cost.	Cost per foot.
Freight	$130.28	$0 044
Labor and teaming	503.59	0 172
Wood	419.80	0 143
Lumber and drill supplies	205.24	0 070
Renewals and repairs	200.30	0.068
Diamonds	898.06	0 307
Fireman	496.21	0 169
Superintendence	1,017.03	0 348
Total	$3,870.60	$1 324

For purposes of comparison, samples from actual experience have been procured, showing the cost of boring with diamond drills under like circumstances elsewhere. It is true that differences in the cost of labor, transportation, fuel, and especially in the hardness of the rocks through which the borings are made, are likely to make such comparisons of doubtful value, unless these differences are taken into account. Nevertheless, the figures given above for the working of the Government diamond drill will on the whole compare very favorably with those for operations carried on in other countries under conditions as nearly alike as can be cited. In the New York *Engineering and Mining Journal* of September 22 and 29, 1894, details are given of the cost per foot of boring nine holes on one of the iron ranges in Michigan, the aggregate depth being 2,091 feet. The total cost in this case was $2.374 per foot, as compared with $0.986 per foot with the Government drill at Glendower. No particulars are given, however, as to the character of the rock penetrated on the Michigan property. The items at the latter place are as follows :—

	Cost per foot.
Labor on drill	$0.606
Fireman	0.206
Fuel	0.182
Camp account	0.722
Repairs on drill, bits, core barrels, etc	0.126
Repairs on boiler and machinery and sundry supplies	0.097
Carbons	0.239
Superintendence	0.196
Total	$2.374

In the *Engineering Magazine* for March, 1896, Mr. J. Parke Channing gives details of the cost of boring 18 holes to a total depth of 5,046 feet in iron ore properties at various places in Michigan. His figures are summarized as follows :—

	Total Cost.	Cost per foot.
Labor on drills	$3,580.27	$0.709
Firemen	1,387.24	0.275
Chopping wood	1,266.01	0.251
Camp account	3,208.44	0.636
Bits and repairs on drills	585.47	0.116
Supplies and repairs on machinery	440.51	0.088
Carbons	1,660.97	0.330
Superintendence	1,006.38	0.199
Total	$13,141.29	$2.604

The material encountered in the holes consisted of iron slates, diorite, jasper, quartzite, etc.

In the same article the expense of operations conducted by Mr. E. J. Longyear, of Hibbing, Minn., comprising 21 holes and an aggregate depth of 4,684 ft. is given. The figures are as follows :—

—	Total Cost.	Cost per Foot.
Labor	$5,569.74	$1.189
Fuel at boiler	735.97	.157
Camp account	2,416.49	.516
Bits and repairs on drills	722.24	.154
Supplies, boiler and pump repairs	226.28	.048
Carbons	3,201.09	.684
Superintendence	1,211.51	.259
Total	$14,083.32	$3.007

The strata passed through consisted of jasper, iron slates, sandstone, and marble.

In the East New York mine at Ishpeming, Mich., 28 holes were bored to a depth of 3,746 ft., of which 193 ft. were in hematite, 646 ft. in jasper, 986 ft. in mixed ore, and 1,921 in dioritic schist. The record of cost as given by Mr. Channing is as follows :—

—	Total Cost.	Cost per Foot.
Labor—400¼ days' setter at $3.00 .... $1,200.75		
372¼ " runner at 2.25 .... 837.00		
230¼ " " at 2.00 .... 460.50		
4½ " laborer at 1.75 .... 7.85		
	$2,506.10	.669
Carbon, 68⅜ carats at $15,144	1,035.47	.276
Bits, lifters, shells, barrels and repairs	433.81	.115
Oil, candles, waste and supplies	128.09	.033
Estimated cost compressed air	374.60	.100
Total	$4,478.07	$1 195

Two instances of underground drilling are given in the same article, in both of which the cost was much less than in the operations conducted from the surface. The first is from the records of the Minnesota Iron Company, and covers a period of twenty months, from May 1, 1894, to December 31, 1895:

—	Total Cost.	Cost per Foot.
No. of feet drilled, 13,312.		
Carbons	$4,587.82	$0.340
Supplies and oils	939.84	0.070
Fuel	547.39	0 40
Shop labor and material	679 01	0.050
Pay roll	3,694.83	0.273
Total	$10,448.89	$0.773

This drilling was all done in the back stopes, almost every foot being in the ore. The drills used were the Sullivan make, "E" size, the holes being 1½ in. in diameter, and from 10 to 40 ft. deep, the machines being operated by compressed air.

The second instance is from work done at the Cleveland mine, Ishpeming, Mich., in 1892. It consisted of 6,075 ft. of underground drilling and 1,414 ft. of surface drilling, with 470 ft. of standpipe sunk.

—	Total Cost.	Cost per Foot.
Carbon	$1,887.00	.237
Supplies and oils	134.13	.017
Fuel	360.73	.045
Shop material, etc.	663.36	.083
Pay-roll	4,000.03	.502
Total	$7,045.25	.884

The last two tables are given in order to show the cost of exploring for ore bodies in working mines, but they are not strictly comparable with the cost of work done by the Government drill, or with surface operations generally, as the latter embraces items of expense, such as freight and teaming, which are absent in the former case.

The Government of New South Wales, Australia, employs diamond drills for exploring purposes, the cost apparently being divided between the Government and the property owner. In 1894 the total depth bored was 557 ft., and the cost for boring, exclusive of reaming, was £468 2s, or 16s. 9½d per foot, equal to $4.07 of our money. This cost seems large and may be partly accounted for by the small extent of boring. In 1893, however, the depth drilled was 1,903 ft., 7 in., at a cost of 12s. 4⅞d per foot, equal to $3.01 per foot. The rate of boring in 1894 was 12.55 in. per hour, and the diameter of the bore was 4 in., much larger than that of the Ontario drill. The expenditure for diamonds was 9d. per foot—almost exactly the same as at the Glendower mine—and the work appears to have been done in basalt interbedded in clay. In 1893 the cost for diamonds was 3s. 3⅛d. per foot—more than four times as great as in 1894. The reason for this difference is not explained.

In the colony of Victoria extensive borings have also been carried on by the Department of Mines for several years in search of auriferous deposits and in prospecting for coal. The aggregate depth bored for gold in 1894 was 28,347 ft. 9 in., and the total cost £10,663 12s. 9d. Of this distance 21,148 ft. 11 in. was put down by means of diamond drills at a cost of £9,673 17s. 6d., or 14s. 3¼d. per foot, equal to $3.47 per foot. Other boring machines on contract drilled 7,198 ft. 10 in at an expense to the Department of £989 15s., or 3s. 6¾d. per foot, to which apparently a like amount is to be added for the share of the cost borne by the private individual or company. In prospecting for coal two types of drill were employed, the diamond drill and the calyx machine. The last mentioned is said to be an entirely new invention, working with steel cutters instead of diamonds, at an expense much less than that of the diamond drill. The cost of operating the latter in the coal measures was 11s. 6d. per foot, while for the calyx machine it was

6s. ½d., a marked difference in favor of the new machine. The following reference to the work of the calyx drill is made in the report of the Superintendent of drills for 1894:—

"In the trial bore the calyx drill demonstrated its capabilities in a decisive manner. The drill as a whole was certainly not much to look at, but its performances were somewhat astonishing. It cut a 5½ in. bore to 700 ft. deep, and produced a perfect core by manual labor and horse gear at less than half the cost of average diamond drill work in similar strata." The superintendent adds that he considers it "possible to evolve from the primary principle of this system the most economical and generally useful boring machine that could be devised" No account is given of the construction of the calyx drill, and no opinion can therefore be formed as to the likelihood of its usefulness in piercing the dense strata of, say, the Huronian system of Ontario. Its use in Victoria seems to have been so far confined to the softer rocks of the coal measures.

In his report for 1894, the Secretary of Mines for Victoria remarks upon a change of principle which was introduced during the year as regards the employment of Government diamond drills. On several grounds, among which that of economy was prominent, it was decided that future borings, whether for gold or coal, should, unless in cases of purely national character recommended by the departmental officers, be done only when the persons requiring it paid one-half the expense. "This change," the Secretary states, "has been productive of much good. The work done by the drills has been restricted to cases where some tangible result might be foreseen, and cases have almost ceased where applications for diamond drill service were made and pressed, apparently in view of the local expenditure of the drill expenses."

It will be observed that the system in use in Ontario, so far as the sharing of the expense between the Government and the party obtaining the services of the drill is concerned, is practically the same as that now in vogue in Victoria after trial of a plan by which the work was done entirely at the cost of the public chest. Under the liberal terms upon which the use of the drill is offered to miners and owners of mineral properties, it would seem that there is plenty of room for its employment in the Province. Should there be an improvement in the nickel mining industry, either by the springing up of an increased demand for the metal or the introduction of new methods in the treatment of the ore, such as the substitution of pyritic roasting and reduction for the expensive roast-heap and coke smelting processes, there would be a large field of usefulness for it in proving some of the many undeveloped copper-nickel deposits of the Sudbury region. The demand for both magnetic and hematite ore to supply the new blast furnace at Hamilton should and doubtless will induce owners of iron properties conveniently situated to examine them with the view of transforming them into producing mines. In the Lake of the Woods, Rainy Lake and contiguous regions are many gold locations of promise, some of which are at the present time being explored by diamond drills in the hands of private parties If the holders of others were equally desirous of ascertaining the quality and extent of the quartz veins on their lands, the assistance afforded by the Government would very materially lessen the cost to them of acquiring this information. We can hardly hope to find in our ancient Huronian rocks, benuded by glacial action as they have been, either coal seams or beds of auriferous gravel, such as are encountered underground in Australia and California, however deep or assiduously we may bore for them: but in exploring for copper, nickel, iron, gold, or stone of any kind, the use of the Government drill might well be extended with advantage to the holders of mining lands and to the Province at large.

The Duty of Pumping Engines.

By Dugald Baird.*

This paper brings before the members of this Institute a comparatively easy method by which the duty of a pumping engine may be found, and furnishes a few examples of such.

The question of extracting water from a mine is a most important one, and is becoming more important as mines get deeper and more difficult to drain. It is, therefore, of consequence that we should be well informed as to the best practice in pumping When it is said that there are, to the writer's certain knowledge, many pumping engines giving as low as 10,000,000 foot-pounds duty for every hundredweight of Welsh best coal, or coal of equal quality, consumed; whereas it is quite easy to get 80,000,000, and quite possible to get 100,000,000 foot-pounds of duty, no apology is required in introducing the subject of this paper.

While it is not possible to select one type of engine and apply it to all mines irrespective of circumstances, still, if there be a choice of types of engines that have been tested and found to be economical, then that which suits the special circumstances of the case should be chosen. For example, if a pit be 1,200 feet deep, and has a growth of water of 50 gallons per minute, the most likely type of pumping engine to be employed is one driven by electricity; whereas in a pit 600 feet deep, with a growth of 1,000 gallons of water per minute, no one would think of applying electricity.

It is well not only to know a great deal about all economical types of pumping engines, so as to be able to choose the proper one for any particular set of circumstances, but also to be well informed about all the bad types, so that they may be avoided.

It is lamentable for both landlord and tenant to find that parhaps 10 to 15 per cent. of the gross output of a colliery is consumed in pumping water, whereas if a proper engine were doing the pumping only 3 per cent. would be required. In addition, with a bad type of engine, requiring a large fuel consumption, the capital spent for extra boilers is large, and would go far in purchasing a good engine, and, in addition to extra boilers, extra labour is to be paid for to fire them, all of which is a steady drag on the colliery, which should be avoided.

The question submitted for consideration is: How are we to find out whether a pumping engine is a good one or not?

A method recommended by consulting engineers begins in the stoke-hole and ends with the actual work done. The scope of this method will be better understood by perusing the list of questions that require to be answered and the list of observations that require to be recorded:

(A) Analysis of the coal used during the test.

(B) Carbon value of the coal used, so that the exact amount of heat (if complete combustion be got) that is placed under the boilers is known.

(C) Analysis of the flue-gases, and the temperature of the same as they pass to the chimney, so as to ascertain whether complete combustion has been attained or if too much air has been admitted; also how much heat is being sent up the chimney.

(D) Weight of coals used and weight of ashes removed, so as to find what is over and above the natural ash in the coal, and thus ascertain how much unburnt coal is being wasted.

(E) The temperature of the feed-water going to the economizer, and its temperature as it enters the boiler, also the quantity of water used.

(F) The condition of the boiler as regards soot outside and scale inside; the area of boiler exposed to the fire and the area of the gratings, so that the boiler efficiency may be calculated.

(G) The percentage of water in the steam supplied to the engine

*Paper read before the Mining Institute of Scotland.

caused by priming, radiation, condensation, and badly arranged steam-pipes.

(H) The indicating of the engine, which includes the following observations and calculations:—

(1) Size and speed of engine.
(2) Pressure of steam in the pipes at the engine.
(3) " " in the boilers.
(4) Initial pressure of steam in the high-pressure cylinder.
(5) Terminal pressure of steam in the low-pressure cylinder.
(6) Average pressure of steam in all the cylinders.
(7) Vacuum in the condenser, and atmospheric pressure.
(8) Total indicated horse power.
(9) Point of cut-off in the high-pressure cylinder.
(10) Ratio of expansion.
(11) Weight of feed-water used per hour per indicated h.p.
(12) " coal burned " " "
(13) " steam used " " "
(14) " " as calculated from the indicator diagrams.
(15) Quantity of water collected at the steam-traps, relief-cocks, and steam-jacket cocks.
(16) Total quantity of heat supplied to the engine per minute.
(17) Total quantity of heat discharged into the condensers per minute.
(18) Percentage of heat transformed into useful work.

(I) Efficiency of shaft-pumps, including:—

(1) Size of rams and buckets.
(2) Length of stroke.
(3) Number of strokes per minute.
(4) Theoretical discharge of each pump.
(5) Actual discharge of each pump.
(6) Vertical height of each lift.
(7) Percentage of useful work done.
(8) Size of suction and discharge pipes, and other details which vary at different places.

Now, while it may be admitted that all this information is useful, valuable, and most of it indispensable—if the whole question is to be gone into of *(a)* the value of the coal; *(b)* the efficiency of the boiler; *(c)* the efficiency of the economizer; *(d)* the efficiency of the steam-pipes; *(e)* the efficiency of the engine; *(f)* the efficiency of the pumps —yet it is possible to find out what are the best types of pumping engines as applied to mines by a simpler process. For this purpose, it is the efficiency of the engine that is alone required. In that case, only a small proportion of the information detailed from A to I would be required.

This brings us to the method carried out by the writer, which he has found to be of great service. It may appear to some members to be somewhat empirical and unscientific, still the writer is of opinion that unless some such method can be adopted and found sufficient (and he claims for this method that it is so) it will be, if not altogether impossible, extremely impracticable to investigate the efficiency of many installations

At almost every colliery the pumping engine is attached to the same range of boilers as the other engines, some of which it would be found could not be detached for testing purposes, and others which it would not be desirable even to stop for a short time, notably the fan-engine where fire-damp is prevalent.

In addition, the difficulties of testing the useful work done by the pumps in almost every case would be such that they could not be overcome. Imagine, for instance, a Cornish engine with six bucket or plunger-sets, each delivering into the one above, and some getting water at their own particular lodgments, and some running back water to keep them going solid. The actual quantity of water delivered per minute or per stroke would require to be taken, which is, practically speaking, impossible.

The following is a description of the method that the writer has adopted, and a test of duties taken on the basis of that method:—

(A) The water in the boilers being lowered to the lowest safe working place so as to prevent priming, its level is carefully marked so that it may be the same at the beginning and end of the test.

(B) By means of two boxes of known capacity, the amount of water actually put into the boilers during the test is carefully measured. The temperature of the water in the boxes is also required in order to get the exact weight per gallon, and it is necessary that the boilers be fed by means of an injector, so that the steam taken from the boilers for this purpose is returned along with the feed-water. The injector should not be allowed to overflow, but if it does overflow, the overflow is to be collected and returned to the boxes. It is necessary that the blow-off pipes of the boilers should be exposed, so that if there be any leakage from them, it may b caught and returned to the boilers or accounted for.

(C) No attention need be paid to the state of the fires at the beginning of the test, during the test, or at the end of it, or to the amount of fuel used, or to the quality of the fuel, or to the good or bad stoking, or to scale on the plates of the boiler. The steam-joints or fittings should be in good repair before starting, and if the donkey feed-pump be used to fill the test-boxes, its exhaust steam must be led into a barrel of water and condensed, the amount of steam used being thereby ascertained.

(D) All the other engines, including the pumping-engine, should be stopped if possible, but if not possible, as in the case of the fan-engine, a register should be kept of the total number of strokes made during a first test, so that during the next test the fan-engine may be run at the same speed. This first test is what may be called the dead-loss test. The steam in the boilers will be maintained at the regular working pressure, but must not be allowed to blow-off at the safety-valves. The duration of this test will depend on how long the pumping-engine can be allowed to stand—12 hours would be a very good length of test, but no test to be at all accurate should be of less than 4 hours' duration. All tests should be done twice, and if they do not agree to within 5 per cent. should be repeated until they do agree. The amount of water that has been put into the boilers during the test is of course carefully noted. The majority of these tests will, as a matter of convenience, be done on idle days.

(E) Another test on exactly similar lines, and called the working test, is made, but in this the pumping-engine is working, whereas it was standing in the previous one. This test should also be verified by repetition. The amount of water used during the dead-loss test will be deducted from the amount used during the working test, and the net amount will be debited to the pumping-engine's account.

(F) The pumping-engine during the working test would be indicated not less than three times, not because it is necessary to indicate it to arrive at the true efficiency of the engine, but to ascertain whether there is not something radically wrong with the internal arrangements and the distribution of steam, and as a useful adjunct to the test.

(G) As regards the pumps themselves, the ascertainment of the actual amount of water pumped at each stage is a very difficult matter, and, in the writer's opinion, any attempt to find this out would be futile. The amount delivered at the surface could, in some cases, be got, but very often a quantity of water is taken away to the condenser, so that, all things considered, there seems no alternative but to take the theoretical amount that the pump would discharge. By so doing, all engines would be placed on the same basis, and this would also be the case should, say, 5 per cent. be deducted from all. The writer prefers to take the theoretical discharge as a basis, being of opinion that in almost every case it takes as much steam to pump a smaller quantity of water as it does to pump the full quantity, whether the smaller quantity be due to leaking valves, packings or joints, or slip at the valve. In most cases the engine lifts the pumping-rods, and they, being heavier than the water, force it up the pipes during the downstroke of the engine. In these cases it, of course, takes the same amount of steam to lift the rods every time, independently of how much or how little water is being pumped. Even in the case of an underground steam pump, forcing water to the surface in one lift, it takes as much steam to force half of the theoretical quantity as it does to force the full quantity, for although one-half of the water is finding an escape through the suction valve or at the packing-gland, the pressure at the end of the ram or bucket, so long as any water is being delivered at the surface, is just the same as it would be if everything were in order; and on indication of the steam cylinder it would be found that the terminal pressure in the high-pressure cylinder would be the same in both cases. The terminal pressure is the real guide to the amount of steam used. One precaution is, however, necessary—all the pumps must be kept going on solid water, as in almost all cases it takes less steam to pump a mixture of air and water than solid water, the exception being when an engine on the surface working with rods in a vertical shaft has no bucket-lifts, which is very seldom the case; but in that event, the rods being heavier than the water, the steam is used in lifting the rods, and not in lifting the water. It may here be noted that water run back from the rising-main of pipes to keep the pumps solid does not interfere with the amount of steam used. It is to be recommended, however, before the test is begun, that all defective valves, buckets and packings be renewed, so that the pumps could be said to be in good working order. It is also obvious, if the piston-ring of the steam-cylinder be broken or worn, or the steam-valves in a bad state of repair, that such defects must cause the engine to give bad results, and all such gross defects must, if the type of engine has to get a fair chance, be put in order. Of course, should the test be carried out, the result will be the duty as it is under these circumstances.

(H) Having, by means of the test described, found out how much water has been put into the boilers, and having by calculation found out how much work has been done, it remains to reduce them to some standard so that the result may be stated. The standard usually adopted for pumping-engines is foot-pounds of work done per cwt. of coal used, and this has been taken in the following tables. But should anyone who has been accustomed to reduce results to pounds of coal used per hour per indicated horse-power desire to use that standard, it is easy to find the one from the other. By calculation it is found that 1 lb. of coal used per hour per indicated horse-power on the one standard is equal to 221,760,000 foot pounds, or taken approximately, and in a way easily remembered, 222,000,000 foot pounds of duty.

(I) Now, some coals give an evaporative efficiency of 14 lbs. of water per lb. of coal consumed, while other coals only give 5 lbs. of water per lb. of coal. The writer has adopted as a basis a coal giving 10 lbs. of evaporative efficiency, so that if 1,120 lbs. of water be evaporated it signifies that 1 cwt. of coal has been burned. The duty is thus expressed in millions of foot-pounds per cwt. of coal on a 10 lbs. evaporative basis.

Table I. contains examples of tests made under the foregoing conditions. These tests were made rather hurriedly; most of them have been verified, while others have not. They are not to be taken as recording the ultimate values of the relative engines, and were made principally to illustrate the mode of testing, as above described.

After these results have been tabulated, it will sometimes be found that different types of engines give almost the same duty. In that case, another test may have to be applied, so as to ascertain their relative merits as regards steady action. As pointed out in a short paper by the writer recently read to the members, entitled "Pumping Engine Velocity diagrams,"* the pumping engine that can perform a certain amount of work at a speed nearest to that of the uniform velocity, and at the same time give a sufficient pause at the ends of the stroke, is superior to one that, although giving out the same duty, does its work by leaps and bounds. This test is a very simple one when one has a machine for the purpose.

*Trans. Fed. Inst., Vol. ix., page 158.

TABLE I.

Name of Colliery	Leven	Leven.	Leven.	Durie.	Wellsgreen.
Reference Number	1.	2.	3.	4.	5.
Date of test	Nov., 1895	Dec., 1895	Dec., 1895	Jan., 1896	Jan., 1896
Type of pumping engine	Bull	Davey differential	Duplex	Davey differential compound	Compound Bull
Position of pump'g engine	Surface.	Underground.	Underground.	Surface	Surface
Dimensions of cylinders:					
Diameter: inches	100	36	22	33.52	28.48
Stroke: inches	144	48	24	108,144	144
Age of engine: years	18	2	2	8	6
Cndition of engine	Good.	Good.	Good.	Good.	Good.
Duration of test: hours	4½	4	4	4½	6
Pressure of steam at boiler during test: lbs. per square inch	53	53	53	80	77
Water used per hour during dead loss test: gals.	751	751		497	122
Water used per hour during working test: gals.	1,530	1,925		1,032	416
Nett water used per hour during working test: gallons	779	1,174		535	294
Temp'rature of feed-water in test-boxes: Fahr. °	44	42		40	58
Temp. of water going into boilers: Fahr. degrees	130	125		118	140
Dimensions of pumps	Plunger sets—3 of 24 in. 2 of 16 " Bucket sets—1 of 63½ in 1 of 16¼ " 1 of 14¾ "	Quadruple plunger sets—11 inches	Quadruple plunger sets—12 inches	Plunger set—2 of 24 in. Bucket set—1 of 16 in.	Plunger set—1 of 18 in. Bucket set—1 of 18 in.
Length of possible stroke: inches	144	48	24	144	144
Length of actual stroke: inches	141	46	23	141	138
No. of strokes per hour	133	968	705	263	141
Theoretical quantity of water pumped per min. to the surface: gallons	753	900	....	1,030	311
Theoretical amount of work done per stroke: foot-pounds	2,962,080	65,912	405,000	1,265,261	667,000
Total depth of pit: feet	900	900		600	504
Total duty per 1,120 lbs. of water put into boilers: foot-pounds	50,265,312	41,360,000		69,705,390	35,827,200

TABLE II.

Reference Number.	Type of Pumping-engine.	Speed in Double Strokes per Minute.	Length of Stroke.	Average Velocity per Minute.	Average Velocity of Upstroke per Minute.	Average Velocity of Downstroke per Minute.	Greatest Velocity of Upstroke per Minute.	Greatest Velocity of Downstroke per Minute.	If Average Velocity be taken at 100 Feet per Minute, then Greatest Velocity per Minute is equal to
			Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1	Bull	2·6	12	62·4	124·0	99·0	166·5	123·5	266
1A	do	3·0	12	72·0	135·0	99·0	187·0	120·0	260
2	Underground Davey differential	10·0	4	80·0	106·4	78·6	132·3	144·7	180
2A	do do	19·0	4	152·0	182·0	170·3	251·8	270·0	177
3	Underground Duplex	16·5	2	66·0	120·0	122·0	140·0	140·0	212
4	Surface differential	5·0	12	120·0	180·0	144·0	214·0	210·0	178
5	Compound bull	2·3	12	55·4	96·0	68·5	142·5	76·0	257

The speed diagrams are not given as ultimate diagrams for the types of engines tested, but to illustrate what is required. They were taken with the pumping engines going at their usual speeds, but for proper comparison so as to put every pumping engine on the same basis, a set of diagrams should be taken when the pump-rods are moving at an average speed of 100 feet per minute, for a little consideration will show that an engine making a small average velocity, by going fast and making long pauses at the ends of the strokes will, on the comparison of maximum with average velocity, come out badly.

A series of steam cylinder indicator diagrams were taken from all the pumping engines referred to in Table I., with the McKinnell and

Buchanan improved indicator. The leading feature of this indicator is that the springs are arranged externally, and are thus removed from direct contact with the steam piston of the indicator. A more accurate register of the steam pressure is obtained, it being a recognized fact that a spring has not the same rigidity when it is hot as when it is cold. In the usual arrangement the spring is subjected to variations of temperature, so that this indicator is an improvement in that respect; besides, the changing of the springs to suit the different pressures to be registered is more easily carried out.

Should this paper succeed in drawing the attention of the members to the subject of the duty of pumping engines, and bring forth such a criticism as the subject deserves, or should it be the means of enabling any of the members to test their pumping engines in a way not usually adopted, then this paper will not have been written in vain.

Notes on Gold Milling.

By E. B. Preston, M. E. California State Mining Bureau.

(Continued.)

GRINDING AND AMALGAMATING MACHINES.

Arrastras.—Although the arrastra has been largely superseded by the stamp-mill, the fact remains that it is the best and cheapest all-round gold-saving appliance we have. Hence, its use is always indicated where small, rich veins are worked in the higher mountain regions, but it is also found valuable placed below the present quartz mill, where the waste waters from the mill can be picked up and used over again for power on horizontal or overshot wheels. In these cases, it handles the tailings from the mill after they have passed over the concentrators and canvas plants. This part of the milling is usually leased to parties who pay the mine a fixed amount per ton for the tailings, the lessees putting up all of their own machinery. These arrastras are built of a size to handle at least 4 tons of tailings in twenty-four hours. Their foundations are either formed of hard rammed clay, concrete, or a plank platform with broken joints, on which a bed of clay is placed. The foundation is always made larger than the circumference of the proposed arrastra. The bed is formed of rocks harder than the substance to be crushed, usually fine-grained basalt, granite, or quartzite. These are picked with a partially level surface, and as near of the same thickness as possible, usually from 1 ft. to 2 ft. thick. They are built around a centre cone, forming an annular ring from 2½ ft. to 6 ft. wide, and are laid with narrow spaces between each rock, into which dry clay should be tightly rammed to within an inch of the surface. The outer circle is formed of rocks or staves, with rammed earth behind, and built from 2 ft. to 4 ft. in height. On the central cone, which consists of stone or a block of wood, and which stands somewhat above the paved bottom, a center post is let in, from which project four arms at right angles to each other, and extending nearly to the outer circle. Heavy, hard rockdrags, weighing from 200 to 1,000 lbs. each (from 400 to 600 lbs. is the usual weight), are attached to the arms by ropes or chains passing through eye-bolts secured in the rock-drags. They are placed so that part of them drag near the cone, with the inside corner slightly in advance, while the remainder sweep near the outer circle with the outer corner in advance. The front edge should always be slightly elevated, so as to permit of the particles passing under the drag instead of being pushed ahead.

Where a horizontal wheel is used, the arms are attached to the centre post and the wheel encircles the arrastra, the water striking on buckets set to an angle of 45°. With overshot wheels the arrastra may be run by a belt and pulley attached to the center-post, or by a spur gearing. It requires about 6 h. p. to run an average-sized arrastra. Running tailings, a speed of 15 to 30 revolutions per minute is given; crushing ore, the arrastra should be run slower and the pulp thicker.

For discharging the arrastra, plug-holes at different levels are put into the outer circle, leading the pulp into sluices lined with plates, riffles, and blankets. In some cases the arrastra has been made to work continuously by fitting a screen to a part of the outer circle and letting it discharge into a line of sluices. As the arrastra bottom and drags are extremely uneven and rough when first set up, some coarse sand and water are introduced on first starting, and the drags are allowed to run slowly until somewhat smoothed down, before the regular charge is introduced. The machine is usually only cleaned up thoroughly when the bottom is worn away; between times the crevices are picked out for the depth of an inch or two with picks, scrapers, and spoons, and panned out, with what pulp remains on the bottom, after the charges have been successively thinned down and run off through the plug-holes. If creviceing has been done a little fresh clay can be rammed in to within 1 in. of the top of the bed. During the grinding of the charge, the quicksilver is introduced through a cloth; the amalgam should be kept drier than in the stamp battery, though not sufficiently so as to become "crumbly." Great attention must be paid to tamping the bed in solid, otherwise an excessive loss of quicksilver may occur. Continual horn tests of the pulp furnish a guide for the proper working.

Machines have, from time to time, been introduced in California to replace stamps, claiming to do more effective work, both as regards the crushing as well as the amalgamating. Those mostly seen in operation, and finding the most favor, are the Huntington and Bryan mills, which may be taken as types, and which reduce the ore by a continuous rolling motion; in the one case the roller acting on a ring on the circumference, and in the other on dies in the bottom.

The Huntington Mill consists of a shallow iron pan with a central cone, through which an iron shaft revolves. Bolted on the sides of the pan and inclosing it, are semi-circular iron sections made in two halves and also bolted together; one of these sections contains an opening about 9 in. deep, divided into three parts, into which curved iron screen-frames are keyed, while the other section contains a feed-trough, attached near the top. Between the bottom of the pan and the lower edge of the screen-frames an iron or steel ring-die fits against the sides of the shallow pan, being secured by wooden wedges; against this die, four rollers, suspended from yokes resting on an iron cover, revolve, receiving their motion from the central shaft. These suspended rollers are pressed by centrifugal force against the ring-die. Each roller is encircled by an iron or steel shoe fastened by wooden wedges; this can be renewed when worn too thin, or when it becomes unround—flattened. Means are provided for lubricating the shafts on which the rollers work, without permitting the lubricant to come in contact with the pulp. As the rollers hang about ½ in. above the bottom of the pan, scrapers are attached to the revolving cover between the rollers, and reaching to the bottom of the pan, to prevent the baking of the pulp.

The size of the pan most frequently used is 5 ft. in diameter, though for prospecting purposes one of 3½ ft. is also made; the former is run at a speed of 70 revolutions per minute, the latter at 90 revolutions. They are provided with self-feeders, which introduce the ore at regular intervals—the only way in which they can be operated, though not correct in principle. A 5 ft. mill requires about 8 h. p., and crushes about 20 tons per day. Before starting up a certain amount of quicksilver, up to 50 lbs., is introduced into the pan with some water and rock. The supply should be regulated to make a stiffer pulp than in a stamp battery; quicksilver is added from time to time. A groove in the bottom of the pan, connecting with a plug-hole on the outside, permits of the quicksilver and amalgam being drawn off at intervals to recover the latter, after which the former is returned. If the pan is working correctly the bottom around the centre remains bare; this can be observed through the cover while running; when not bare it is a sign that the pan is being overfed. As the machine throws the pulp with considerable violence through the curved screens, a shield is placed outside of them, directing the pulp into a narrow sluiceway with a spout opening on the apron-plate. It is claimed that the percentage of gold amalgamated and saved on the inside is far greater than in the stamp-mortar, going above 80%; all rusty gold being subjected to a heavy scouring action. The Russian-iron screens used are short-lived; they can be made to last somewhat longer by placing a false screen made from an old worn screen with the openings enlarged, between the pulp and the screen proper.

Great care must be exercised in putting up one of these machines, to get it perfectly level and on a rigid foundation, and to keep all the bolts holding the pan on the foundation well tightened up; the feed also requires close observation.

When cleaning up or renewing the ring-dies or shoes, the top cover, with the suspended rollers, are lifted out with chain, block and tackle, leaving the interior of the pan free for operation.

The mill works well on soft quartz and clayey ores, introduced in pieces not larger than walnuts. A great drawback to the machine is that the rings on the rollers and also the dies become "unround," so that instead of rolling smoothly, they strike in places necessitating changing the rings before they are worn out; this changing takes up some time.

The opinions of millmen who have handled the Huntington mill, as to its merits, are very diverse. Where the ore produces a large amount of fine stuff, by using a grizzly with closely set bars, the Huntington can be run to advantage on these "smalls" in conjunction with the stamps.

The Bryan Roller Mill is a modified form of the Chili mill, built in sizes of 4 ft. and 5 ft. diameter. It consists of an annular mortar with an outside gutter and spout, cast solid, containing steel dies arranged in the track of three crushing rollers, which in the 5 ft. mill have a crushing face of 7 in., a diameter of 44 in., and weigh 3,650 lbs. They have fixed axles, "journaled" in a central revolving table, attached to and driven by a belt pulley. This pulley is a cylindrical tank, which in the smaller pattern, rests immediately on the rollers, and can be made to increase their crushing power by being loaded. The mortar is supplied with curved screen-frames around the entire machine, the pulp being discharged all around into a gutter delivering through a spout, on one side, to an apron-plate.

The chief wearing parts are the steel dies and tires on the rollers; these latter are fastened to the rollers by wooden wedges. According to the statement of the manufacturers (Risdon Iron Works, San Francisco), one set of these wearing parts will crush from 4,000 to 8,000 tons of ore in the large size, and 1,500 to 2,000 tons in the smaller size, and at the rate of 25 to 35 tons and 12 to 20 tons per day with a speed of 30 and 60 revolutions, respectively, per minute, the smaller size requiring from 5 to 6 h. p. The oil channels for lubricating the bearings are arranged to prevent the oil from entering the mortar. To keep the pulp from baking to the rollers or dies, and to assist in equalizing the ore received from the feeder, scrapers with adjustable springs follow each roller. They are also provided with self-feeders. In operating the mill, ore, water, and mercury are introduced into the mortar, the pulp passing around next the screens in a current not less than 300 ft. per minute, while the motion inside of the rollers is much slower. The amalgam, working its way toward the center cone, is kept from being re-ground, and can be observed while the mill is in operation; it is claimed to retain 80% of the amalgam in the mortar. To clean it up, the dies between the rollers are removed, the pulp and amalgam taken out, and wooden blocks of the thickness of the die put in their stead, on which the rollers are revolved, when the remaining ones can be taken up. It is claimed for these mills, that they wear smooth, and even while crushing hard quartz, discharge freely (on account of large screen area), avoid sliming and flouring of quicksilver, are good amalgamators, can be cleaned rapidly, are easily put in place, and require small power for amount of work done.

The Griffin Mill belongs to that class of mills using a roll running against a ring or die; but instead of several rollers, as in the Huntington, this has one roller only, swinging from a longer shaft, hung from a point in the central axis of the mill, and rotated about its own axis by the power applied at the top. It is run at a speed of 190 to 200 revolutions per minute, crushing from 1½ to 2½ tons per hour, the power being applied to a horizontal pulley above, from which the shaft is suspended with a universal joint, and the roller is rigidly attached to to lower extremity of the shaft. The roller swings in a circular pan supplied with a ring or die, against which the roller works; and carries on the under side scrapers or plows to prevent the pulp from baking. A circular screen-frame is fastened on the pan, to the top of which a conical shield is attached at the apex, through which the shaft works. The pulley revolves upon a tapered and adjustable bearing, supported by the frame composed of iron standards, two of which are extended above the pulley to carry the arms in which is secured the hollow journal-pin. The shaft is suspended to a universal joint within the pulley. This joint is composed of the ball or sphere with trunnions attached thereto, which work in half-boxes that slide up and down recesses in the pulley-head casting. The lubricant is supplied, for all parts needing it, through the hollow pin. The roll revolves within the ring-die in the same direction that the shaft is driven, but on coming in contact with the die, it travels around the die in the opposite direction from that in which the roll is revolving with the shaft. A pressure, by centrifugal force, of 6,000 lbs. is brought to bear on the material being pulverized between the roll and die. The water is introduced with feed when running, and receives a whirling motion from the roll, which brings the pulp against the screens, 9 ft. in area. A circular trough on the outside of the pan conducts the pulp to one side, where it discharges over an apron.

Specifications for a Forty-Stamp Gold Mill. (Water Power).*

MACHINERY.

Water Wheels and Pulleys.—One water wheel, 6 ft. in diameter, to drive the battery; the wheel to be supplied with a shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 36 in. in diameter, grooved for 1½ in. manilla ropes.

* From the VIIIth Report of State Mineralogist, 1888, p. 728.

One driving pulley, 12 ft. in diameter.

One idler pulley, 48 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft and boxes.

One slack-tightener pulley, 48 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft, boxes, carriage, track, and counterbalance weight.

The rope for transmission is to be put on in one piece, passing around the idler and slack-tightener (which are to be set on an angle in such a way that they will take the rope from one side of one of the main pulleys and pass it on to the opposite side of the other pulley), thereby making but one splice in the whole rope, which will be kept in constant tension by the slack-tightener.

One wheel, 4 ft. in diameter, to drive the rock-breakers; the wheel to be supplied with a shaft, boxes, collars, gate and nozzle, and a pulley 34 in. in diameter, grooved for one 1½ in. manilla rope.

One driving pulley, 60 in. in diameter.

One idler pulley, 30 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft and boxes.

One slack-tightener pulley, 30 in. in diameter, grooved for one 1½ in. rope, and fitted with shaft, boxes, carriage, track, and counterbalance weight; rope to be put on similar to that for the battery.

One wheel, 36 in. in diameter, to drive the concentrators; the wheel to be supplied with shaft, boxes, collars, gate, and nozzle, automatic governor, and a pulley 16 in. in diameter, grooved for one 1 in. manilla rope.

One driving pulley, 48 in. in diameter.

Forty-Stamp Battery—Stamps to weigh 850 to 900 lbs. each, arranged to run in eight batteries of five stamps each, by belts and friction clutch pulleys from battery line shaft.

Eight high cast-iron *Mortars*, single discharge, each to weigh about 5,000 lbs.; to be planed all over the bottom, and faced where the apron joins on; eight holes to be accurately cored in the base for 1½ in. anchor bolts. Each mortar to have five cast-iron linings. The aggregate weight of these linings is about 500 lbs. per mortar.

Eight cast-iron *Aprons*, to be faced where they join on to the mortars, and fastened in place with ¾ in. bolts.

Eight sugar-pine *Screen Frames*, to have iron facings put on the ends where the keys bear against them; the edges to be fitted with dowel-pins to join them to the inside plate-block.

Sixteen inside *Plate-Blocks*, two sets, one to be 6 in. high, and the other to be 4 in. high; to be well fitted into the mortars, and to have plates fitted and fastened on with brass screws; blocks to be bolted together to keep them from splitting, and to be fitted with iron facings where the keys bear against them, and well fitted to the screw frames.

Eight brass wire *Screens*, No. 30 mesh, to be fastened on to the screw frames with copper tacks.

Sixteen gilt-headed *End Keys*, for screen frames to be well fitted in place.

Sixteen *Bottom Keys*, for screen frames, to be well fitted in place.

Sixty-four *Foundation Bolts*, for mortars, to be 1½ in. in diameter by 30 in. long, with hexagon nuts on the top ends and steel keys in the bottom ends.

Sixty-four wrought-iron *Washers*, 4 x 4 x ¾ in., for bottom ends of foundation bolts.

Eight sheets of *Rubber*, ¼ in. thick by 30 x 60 in., for mortar foundation. Mill blankets tarred may be used in place of rubber.

Forty chrome steel or cast-iron *Dies*, 9 in. in diameter by 7 in. high, with square base well fitted into the mortars, 10 in. from centre to centre.

Forty chrome steel *Shoes*, 9 in. in diameter by 8 in. high, with tapered shank 3¾ in. in diameter at top end, 4¾ in. in diameter at bottom end, by 5 in. long, to fit into the stamp-heads by being covered with dry, hard pine ⅜ in. thick; this being driven in by being allowed to drop a few times on the bare die.

Forty chrome steel *Stamp-Heads*, 9 in. in diameter by 17 in. long, with a conical socket cored into the lower end, 4 in. in diameter at inner end and 5⅞ in. in diameter at the outer end, and 5½ in. deep, and a conical socket cored and accurately bored out to fit the tapered end of the stamp stem, 2⅞ in. in diameter at inner end, and 3¼ in. gauge at the outer end, by 6 in. deep. Transverse rectangular keyways are to be cored through the stem-head, 1 x 2½ in., for loosening the shoes and stems.

Two steel *Loosening Keys*, ⅞ in. thick by 1 in. at the point (2 in. at the head) by 18 in. long, for loosening the shoes and stems.

Forty best refined iron or mild steel *Stems*, turned perfectly true, full length, 3¼ in. gauge by 14 ft. long, to be tapered on both ends to accurately fit the stamp-heads. Each stem weighs about 360 lbs.

Forty chrome steel, double-faced *Tappets*, 9 in. in diameter by 11 in. long, with a steel gib and two steel keys accurately fitted in place; both faces to be turned true; tappets to be bored with the gibs in place to accurately fit the stems, and to be counter-bored opposite the gibs by moving the centre ¼ in. away and, with diameter ⅛ in. less than the bore, taking a cut ⅛ in. deep. Each tappet weighs 112 lbs.

Eight *Upper* and eight *Lower Guides*, with cast-iron frames; guide-blocks to be made of good, dry maple timber and well fitted in place; the guides may also be made entirely of wood.

Four extra quality, mild steel *Cam-Shafts*, turned true full length, 5½ in. gauge diameter by 14 ft. long; key-seated for cams and pulley; key-seats must not run through the bearings.

Ten heavy *Corner Boxes*, 5½ in. gauge bore; eight of them to be 12 in. long, and two to be 20 in. long; all of them to be planed all over the bottoms and backs, and furnished with bolts 1 in. in diameter, to fasten them to the battery frame.

Forty double-armed, chrome steel *Cams*—twenty right and twenty left hand—to be made 29 in. long over all, the hub to be 11 in. in diameter and 5½ in. through the bore; the lifting faces to be 2½ in. wide, and ground smooth; the hubs to be bored to fit the shaft accurately, and properly key-seated and fitted with steel keys, and each marked to their respective places, giving them a combination as follows: Counting from the left-hand side, when facing the battery, throughout the full ten stamps of each cam-shaft, No. 1 cam will drop its stamp first; then Nos. 8, 4, 10, 2, 7, 5, 9, 3, and 6 consecutively. This is the order: 1, 4, 2, 5, 3. Each cam weighs about 158 lbs. The curve of the face of the cam is the involute of a circle, usually slightly modified.

Four pairs of cast-iron double *Sleeve Flanges*, for wood pulleys; flanges to be 36 in. in diameter, and 14 in. through the bore; to be turned all over the inside, where they fit on the wood; the outside flange is to be bored and fitted to the sleeve and fastened with a gib-headed steel key; the hub to be bored and fitted to the cam-shaft and fastened with a steel key.

Four *Wood Pulleys*, 72 in. in diameter by 17 in. face; to be made of best kiln-dried sugar-pine, and all joints to be filled with white lead in oil; the cast-iron flanges to be well fitted on and bolted with twelve ⅞ in. bolts.

Eight wrought-iron *Collars* for cam-shaft, 5½ in. bore, fitted with two steel set-screws in each.

Eight wrought-iron *Jack-Shafts*, 3 in. in diameter by 60 in. long, black finish.

Sixteen cast-iron *Jack-Shaft Side Brackets*, with four lag-screws, ⅜ in. by 6 in., for each, to fasten them in place.

Forty open *Latch Sockets*, lined with leather.

Forty wood *Finger-bars*, to be fitted and bolted to the above sockets, and furnished with wrought-iron caps and handles.

A complete set of *Water-Pipes* for a battery of forty stamps, with all fittings, cocks and connections.

Bolts and Washers for Battery Frame.—Six brace rods, 1¼ in. x 25 ft., 7 in. between two nuts; 6 brace rods, 1¼ in. x 12 ft., 6 in. between two nuts; 26 bolts for mudsills, 1 x 30 in.; 24 bolts for yokes, 1 x 28 in.; 24 bolts for yokes, 1 x 52 in.; 48 bolts for guide girts, 1 x 32 in.; 4 bolts for knee beam, 1 x 28 in.; 36 splice bolts for mudsills, ⅞ in., 16 in. between head and nut; 12 splice bolts for tail girt, ⅝ in., 9½ in. between head and nut; 32 bolts for mortar-blocks, 1 in., 59 in. from point to point; 64 bolts for mortar-blocks, 1 in., 65 in. from point to point; 24 joint bolts for posts, 1 in., 35 in. between two nuts; 6 joint bolts for knee posts, 1 in., 45 in. between two nuts; 6 joint bolts for knee posts, 1 in., 35 in. between two nuts; 24 joint bolts for knee beams, 1 in., 43 in. between two nuts; 10 joint bolts for tail girts, 1 in., 21 in. between two nuts; 24 cast-iron washers for 1¼ in. rods; 514 cast-iron washers for 1 in. bolts; 72 cast-iron washers for ⅞ in. bolts; 24 cast-iron washers for ⅝ in. bolts; 40 sheet-iron washers, 3½ in. square by ¼ in. thick, for 1 in. joint bolts.

Battery Line Shafting and Pulleys.—One shaft, 5½ in. gauge by 18 ft. long, properly key-seated; one shaft, 5 in. gauge by 15 ft. 6 in. long, properly key-seated; one shaft, 5 in. gauge by 17 ft. long, properly key-seated; one shaft, 4 in. gauge by 17 ft. long, properly key-seated; two shafts, 3 in. gauge by 10 ft. 6 in. long, properly key-seated; two face couplings, 5 in. gauge, properly fitted and keyed in place; one face coupling, 4 in. gauge, properly fitted and keyed in place; two face couplings, 3 in. gauge, properly fitted and keyed in place; two babbitted boxes, 5½ in. gauge; three babbitted boxes, 5 in. gauge; two babbitted boxes, 4 in. gauge; two babbitted boxes, 3 in. gauge; all of the above boxes to be made of the same height, planed all over the bottoms, with drip cups cast on to the sides, and furnished with suitable bolts to fasten them to the 16 in. battery knee beams; two collars for 5½ in shafting, with two steel set-screws in each; four friction clutch pulleys, 48 in. in diameter and 16½ in. face, complete, with levers and connections; pulleys to be fitted to line shaft in their proper places, with phosphor-bronze bushings, the drivers to be properly keyed on with steel keys; one pulley, 6 ft. in diameter, grooved for three 1½ in. manilla ropes, pulley to be well balanced and keyed to the shaft with a steel key.

Water-Pipes.—Sufficient 3 in. pipes and fittings to connect battery pipes with feed-water tanks.

Travelling Hoist.—One travelling crab, with track-iron and rails, to extend full length of battery.

One 2-ton Weston's differential chain-block.

Ore-Feeders.—Eight Challenge self-feeders, complete, for batteries, with all connections.

Ore-Bin Gates.—Eight ore-bin gates, 18 x 24 in., for fine ore, with guides, racks, pinions, shafts, boxes, hand-wheels, and bolts.

Three ore-bin gates, 24 x 36 in., for coarse ore, with guides, racks, pinions, shafts, boxes, hand-wheels and bolts.

Sluices and Aprons.—Eight cast-iron aprons, 54 in. wide by 56 in. long, to be fitted under the lip of the mortar apron.

Eight silver-plated copper plates, 54 x 56 x ⅛ in., to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the cast-iron aprons, and fastened by strips of wood on the sides, which are bolted to the sides of the apron.

Eight cast-iron sluices, 54 in. wide by 12 ft. long, to be made into two sections and bolted together by flanges, the lower section to have a quicksilver trap or trough cast on to the end, extending the full width of the sluice, and to have a connection made for a 2 in. pipe to conduct the pulp to the dividing tanks, and thence to the concentrators.

Twenty-four silver-plated copper plates, 54 x 48 x ⅛ in., to be made of best Lake Superior copper, and to have one ounce of silver per square foot; plates to be fitted into the sluices, overlapping at the joints, and to be fastened in place in the same manner as those in the apron.

There are to be eight silver-plated copper shaking-tables, one for each battery, placed below the apron-plates. These tables consist of a light iron framework suspended upon moveable springs. This table is given a longitudinal oscillation by means of eccentrics.

Dividing Tanks and Pulp Pipes.—Eight cast-iron dividing tanks, 10 in. long by 8 in. wide by 6 in. deep, with 2 in. pipe connection in one end and two 1½ in. pipe connections in the other end, each to have a wooden swinging tongue put in so as to direct the pulp to either of the 1½ in. pipes, or a part to the one and a part to the other. The tanks are to be connected with the sluices by 2 in. pipes, and with the concentrators by 1½ in. pipes.

Inside Plates and Blocks.—Three wooden blocks for each mortar, to be 3 in. 4½ in., and 6 in. high, respectively, to be fitted into the mortars under the screw frames; each block to have iron facings, fitted in flush and screwed on where the keys come, and to have a silver-plated copper plate bent to the proper shape and screwed on with silver-plated brass screws; the copper plates to be made of best Lake Superior copper, 6 in. x 50 in. x $\frac{1}{16}$ in., and to have one ounce of silver per square foot.

Concentrators and Shafting.—Sixteen endless belt concentrators, complete, with water-pipes and fittings to connect with supply tanks. All sulphuret tanks, complete, to be made of good redwood lumber.

One piece of shafting 2½ in. x 16 ft.; six pieces of shafting, 2 in. x 16 ft.; three pieces of shafting 2 in. x 10 ft.; eight face couplings, 2 in.; four babbitted boxes, 2½ in., with bolts for 8 ft. timber; eighteen babbitted boxes, 2 in., with bolts for 8 in. timber; 2 collars, 2½ in., with steel set-screws; two collars, 2 in., with steel set-screws; one pulley 48 in. in diameter, grooved for one 1 in. rope, and properly fitted and keyed with a steel key to 2½ in. shaft; two pulleys, 6 in. face by 36 in. in diameter, properly fitted and keyed with steel keys to the 2 in. shaft; sixteen pulleys, 4 in. face and 10 in. in diameter, properly fitted and keyed with steel keys to the 2 in. shaft; sixteen loose pulleys, 4 in. face by 10 in. diameter, properly fitted to the 2 in. shaft; sixteen collars with steel set-screws for same.

Rock-Breakers and Shafting.—Two rock-breakers, 9 in. x 15 in; one piece shafting, 4 in. x 16 ft.; one piece shafting, 3½ in. x 16 ft.; one piece shafting, 3 in. x 16 ft.; one face coupling, 3½ in.; one face coupling, 3 in.; three babitted boxes, 4 in., with bolts for 10 in. timber; two babbitted boxes, 3½ in., with bolts for 10 in. timber; two babbitted boxes, 3 in., with bolts for 10 in. timber; two collars, 4 in., with steel set-screws; one pulley, 48 in. in diameter, grooved for 1 in. and 1½ in. manilla rope, and properly fitted and keyed to the 4 in. shaft, with a steel key; three pulleys, 20 in. straight face by 20 in. in diameter, properly fitted and keyed to the shafting.

Clean-up Barrel.—One clean-up barrel, 24 in. inside diameter by 48 in inside length, to be made of cast-iron 1½ in. thick, with two discharge openings, 5½ in. in diameter, in the sides diametrically opposite each other, the heads and discharge doors to be accurately fitted; journals to be 4 in. gauge, cast on to the heads; one tight and one loose pulley, 7 in. face by 30 in. in diameter; two babbitted boxes, 4 in. gauge; one driving pulley, 6 in. in diameter by 14 in. face.

Batea.—One batea, 48 in. in diameter, with gears and hangers complete, and tight and loose pulleys, 4½ in. face by 16 in. in diameter; one driving pulley, 9 in. face by 21 in. in diameter.

Machinery for Clean-up Room.—One clean-up pan, 24 in. inside diameter, with tight and loose pulleys.

One driving pulley, 8 in. face by 16 in. in diameter.

One cast-iron washing-tank, 24 in. by 30 in. by 24 in. deep, with three pipe connections for drawing off water.

One cast-iron washing-tank, 30 in. by 36 in. by 24 in. deep, with three pipe connections for drawing off water.

One cast-iron washing-tank, 30 in. by 54 in. by 30 in. deep, with three pipe connections for drawing off water.

One marble top, complete, for washing-tanks.

One side washstand, with pipes and fittings.

All pipes and fittings necessary to bring water to the clean-up pan and washing-tanks.

Retort and Melting Furnace.—One retort, 10 in. x 36 in., inside dimensions, with amalgam trays, condenser, catch tank, furnace front, bearers, bars, smokestack, and base plate, guy rods, dampers, binders, and all pipes and fittings to bring water to the condenser.

One cast-iron melting furnace, complete, with doors, grate-bars, bearers, cast-iron shell, and damper.

Two bullion molds for 500 and 750 ounces.

Four black-lead crucibles, No. 16, with covers.

One crucible tongs for No. 16 crucible.

One skimmer for bullion.

Transmission Ropes and Belts.—Six hundred feet best manilla or cotton rope, 1½ in. in diameter, to drive battery line shaft.

Two hundred and fifty feet best manilla rope, 1½ in. in diameter, to drive rock-breaker line shaft.

One hundred and fifty feet best manilla rope, 1 in. in diameter, to drive concentrator line shaft.

Two hundred feet best rubber belting, 16 in. by 5-ply, for batteries.

One hundred and eighty feet best rubber belting, 10 in. by 4-ply for rock-breakers.

Thirty-two feet best rubber belting, 7 in. by 4-ply for clean-up barrel.

Sixty-five feet best rubber belting, 6 in. by 4-ply, for batea.

Thirty feet best rubber belting, 6 in. by 4-ply, for concentrator shafting.

Four hundred and twenty feet best rubber belting, 3 in. by 4-ply, for concentrators.

Thirty feet best rubber belting, 3 in. by 4-ply, for clean-up pan.

BUILDINGS, AND ERECTION OF MILL, ETC.

Stonework.—All foundations and retaining walls to be built of large stone, properly banded, and well laid in cement mortar, composed of ten parts good, clear sand. two parts good quality of lime, and one part best Portland cement, special care being taken to keep all dirt or clayey material excluded; all exposed faces of retaining walls to be well pointed up and finished with the same material.

Ore-Bins.—Mudsills to be made of 12 in. x 14 in. timbers, laid flatwise; foundation posts to be made of 14 in. x 14 in. timbers; sills, posts, and caps for ore-bins proper to be made of 12 in. x 12 in. timbers, the posts to be boxed 1 in. into the sills and caps; braces for incline bottom, to be made of 10 in. x 12 in. timbers; supporting braces to be made of 8 in. x 12 in. timbers. All planking to be 3 in. thick and lined throughout with 1 in. boards, to break joints over the planks.

Battery Frame.—Mudsills to be made of 14 x 16 in. sugar pine, or good yellow pine free from sap; to be well bedded in concrete, which must be put on the clean bed-rock. Line sills to be made of 12 x 16 in. and 20 x 16 in. sugar pine or yellow pine, of good quality, to be well bolted down to the mud-sills.

Mortar-blocks to be made of two pieces each, to be 30 in. thick and wide enough to fill space between the linesills and battery posts; all to be sized and well fitted. The timbers for mortar-blocks are to be accurately fitted and firmly driven. Blocks to be sized and finished above the floors.

Yokes to be made of 10 x 10 timber, well fitted and bolted to the linesills and battery posts.

Battery posts to be made of 12 x 24 in. and 20 x 24 in. good quality pine timber, to be dressed all over and bolted down to the linesills with 1 in. joint bolts, the large posts to be made with double tennon on the bottom. The knee beams to be made of 12 x 16 in. timber, dressed all over. The knee posts to be made of 12 x 16 in. timber dressed all over. The stringer on top of the knee posts to be made of 12 x 16 in. timber in two pieces, to be spliced with a ship splice, 3 ft. long, stringer to be dressed all over. Knee posts to be framed into stringer with double tennons; outside stringer at end of knee beams to be made of 8 x 12 in. timber in two pieces, spliced with ship splices in centre 3 ft. long, and to be dressed all over.

Bottom guide girt to be made of 12 x 16 in. timber, dressed all over, one piece for each twenty-stamp battery, and to extend past the outside posts 12 in.; the top girt to be made of 12 x 14 in. timber, dressed all over and made the same length as the lower ones; all braces to be made of 8 x 12 in. timber, dressed all over, and framed with double tennons; no keys are to be used in braces or guide girts, but they must be accurately fitted without.

All boxing about battery frame to be ½ in. deep, and where braces or knee beams are smaller than the timbers they frame into, they must be housed in ½ in. deep; *i.e.*, the timber must be boxed out clear across.

The cam-shaft is to be set 4¾ in. from the centre to the centre of the stems.

A 2 in. plank floor is to be put on top of the knee beams, which is to be planed on the under side; also a 2 in. double board floor to be put in back of the battery, on about the same level as the knee beams.

The whole battery frame to be painted with two coats of light-cream paint, properly mixed with oil, and the wood pulleys and guides to be painted blue, the iron work to be painted black. The out-board bearing frame to be made of 12 x 16 in. timber, planed all over, well framed and bolted together, and anchored to a solid stone foundation, as shown in plan, and to be painted same as battery frame.

Water Wheel Frames are to be made of 12 x 12 in. lumber throughout, well anchored down to a stone foundation. That part of the frame which comes above the floor is to be dressed and painted the same as the battery frame.

The water wheels are to be housed with tongued and grooved lumber, 4 in. wide.

BUILDINGS.

Frame Work.—Ore house main frame is to be made of 8 x 8 in. timbers throughout, with 4 x 6 in. girts and studding.

Battery and concentrator rooms frame is to be made of 8 x 10 in. posts and chords, 6 x 10 in. sills, 8 x 8 in. principal rafters and straining beams, 4 x 8 in. truss braces, and 3 x 6 in. girts and studding.

Clean-up, sulphuret, and water-wheel rooms main frames are to be made of 8 x 8 in. timbers, with 3 x 6 in. girts and studding.

Floors—Ore-house floors to be made of one thickness of 2 in. planks.

Battery, concentrator, and water-wheel rooms floors are to be made of 1 x 8 in. lumber, double thickness, surfaced on top, to be supported on 3 x 6 in. joists 18 in. apart.

Sulphuret and clean-up rooms floors are to be made of concrete laid on top of a heavy wood floor, which is to be supported on foundations made of 8 x 8 in. timbers.

Roofs.—All roofs are to be made with 2 x 8 in. rafters 18 in. apart, with 1 x 6 in. board 4 in. apart, and covered with No. 26 standing seam, painted, iron roofing.

Walls.—All walls are to be covered with 1 x 10 in. rustic.

Cornices.—All cornices are to project 24 in., measured horizontally from the walls of building, with a 12 in. frieze and a 5 in. facia made of dressed lumber.

Windows.—All windows, except those for sulphuret room, are to be made of twelve lights of 10 x 16 in. glass, and frames made to suit of dressed lumber, with casing outside 5 in. wide.

Twelve windows are to be put in the ore-house, seven windows in the battery room, six windows in the clean-up room, twelve windows in the sulphuret room, and five windows in the water-wheel room.

Skylights.—Six skylights, made of twelve lights of 10 x 20 in. glass, to be put into the roof of the concentrator room.

Doors.—All doors, both sliding and swinging, to be 3 x 7 ft. x 1¾ in. thick, with panels.

Two sliding doors are to be put in the ore-house, and one outside swinging door in the battery room; one swinging door leading from the battery room to the clean-up room; two sliding doors leading from the concentrator room to the sulphuret room; two outside sliding doors for the sulphuret room; and one outside swinging door for the water-wheel room.

All doors to be set in good substantial casings, outside cased with surfaced lumber, and furnished with all trimmings and locks.

Stairs.—There is to be a flight of stairs at each end of the mill, one flight leading from the battery room floor to the floors above, and one flight of stairs from the battery room floor to the concentrator room floor.

All stair stringers to be made of 2 x 12 in. lumber, and treads of 2 x 10 in. lumber.

Hand Rails are to be put on to the outside of all stairs and around the landings of same, also in front of the battery room floor and all other floors and platforms where there is danger of falling. All to be made of dressed lumber, well painted.

Retort House and Assay Office, to be 20 ft. wide by 48 ft long, with a retort and melting furnace room, a weighing room, and a storeroom; the two latter to be lath and plaster finished, and the whole building to be finished similar to the mill buildings, with iron roof, rustic, etc.

Paint and Whitewash.—All buildings are to be painted on the outside with a good coat of brown mineral paint, and the window and door casings and cornices to be painted with two coats of white-lead paint.

The mill to be whitewashed throughout the inside, including the building frame, ore bins, etc.

Tanks.—There are to be two 4,000-gallon redwood tanks, 3 in. stock, set up at the end of the mill upon strong timber foundations, and one tank 8 ft. wide by 10 ft. long by 4 ft. high, inside measurements, to be made of 3 in. planks, with 8 in. x 8 in. frame; planking to be well fitted together, and properly caulked inside with oakum. The latter tank is to be set at the end of the last sluice-box coming out of the mill.

Drain Boxes and Tailings Sluices.—Battery sluices and aprons to be set on framework so arranged that the grade can be changed easily. This framework to be planed all over. Sluices and frames to be painted same as battery frame.

There will be a sluice in front of battery room floor, made of surfaced lumber; also to be painted and so arranged as to conduct any water away which drips from the floor.

There will be sluices put in under the concentrator room floor, two of which will be 6 in. wide by 8 in. deep, to run lengthwise to catch the tailings from the concentrators, and one to be 8 in. wide by 10 in. deep, to run crosswise and to take the tailings from the first two sluices, and conduct the same outside. All tailings sluices to have a fall of one in twelve, and to be made of 2 in. lumber, well fitted and nailed together. Proper sluices from the clean-up room, to conduct water and tailings therefrom, must be connected to tailings sluices under concentrator room.

All sulphuret boxes, and drain boxes for concentrators, to be made of good quality of redwood lumber, 1¼ in. thick, dressed on both sides, and well fitted and screwed together.

The weight of all parts is 240,000 lbs., and there are 325,000 ft. of lumber in the building.

Specifications for a canvass plant are not considered necessary, as the construction is extremely simple and no standard has been adopted.

Notes on the Eustis Mine, Que.

By Raoul Green, McGill University.

[This paper has been awarded a prize of $25.00, being first in a series of students' competitive papers read before the General Mining Association of the Province of Quebec, January, 1896.]

This paper is the result of careful observation and notes while working in the Eustis mine, where the writer has spent his holidays, so as to get a good insight into practical metal mining.

The writer's work for the Eustis Mining Co. has extended over a period of four months, having been engaged in all kinds of work, from tramming to helping on air and diamond drill.

This mine began work in 1865; during the first fifteen years, with occasional periods of idleness, it was worked for copper only, but nearly continuously since both copper and sulphur were extracted.

The ore is an iron pyrites containing a varying amount of copper pyrites, it is very pure, with very little silica. The copper runs from 3 to 7 per cent., and sometimes varies in going from foot-wall to hanging-wall, the former being the richer, with, however, no fixed rule in this respect, as it sometimes happens that it is the hanging wall part of the vein which is richer in copper.

Wherever hanging veins occur, these are not found to be much poorer or richer in copper than other veins; however, where there is a large percentage of copper there is generally less sulphur.

Two samples, which the writer analyzed gave: for foot-wall vein, 6.01 per cent. of copper; for hanging-wall vein, 3.55 per cent. of copper. Sulphur averages over 42 per cent., while silver is present to the amount of 3 to 4 oz. to the ton.

The dip is very irregular as it follows conformable to the bedding of the surrounding strata, which in this pre-Cambrian district have been very much contorted, being sometimes flat, sometimes at an angle of 60° from the horizon, but averaging about 35° from the horizon.

The ore body, which runs nearly due north and south, consists of one large ore chute or chimney, which varies in width from 150 at the top to 250 ft. at the bottom, having a thickness of 3 to 60 ft. The depth of the lowest workings is now 2,250 ft. measured along the dip. The vein pinches out on the west side; towards the east it is thicker, from 20 to 30 ft. in places, but is very irregular, as it runs in pockets and lenticular masses, besides being very silicious.

There are two inclines or shafts following the dip of the vein and slightly separating as they go down, then continuing parallel when a distance of 150 ft. from each other has been reached—namely, No. 1 on the west side, No. 3 on the east side.

Recently two new veins have been found overlying the hanging of No. 1 shaft. At about 2,000 ft. from the surface, the vein in No. 1 shaft was found to pinch out to some extent; the existence of a hanging vein was therefore suspected. Accordingly holes were drilled, by means of the diamond drill, which revealed two veins separated from each other by a splice of rock 10 ft. wide.

The middle vein, which is from 8 to 9 ft. in thickness, has a length east and west varying from 20 to 40 ft. The top vein is, so far as proved, a wedge or triangular shaped body with the apex above and lengthening out in depth. It has proved to extend for 100 ft. in length, with ore standing in the east end.

These two veins have been traced upwards along and parallel to No. 1 main ore body for over 150 ft., but have not been found to extend over No. 3 shaft.

The discovery of these new veins is quite interesting, as it shows how ore bodies can exist parallel but without any connection with each other, having probably been developed along a line of fault.

The mine is penetrated by means of a tunnel into the hillside, meeting the vein at 200 ft. from the surface. This tunnel is single-tracked, 7 x 7 ft., and 1,000 ft. in length, with a grade of 6 in. per 100 ft.

At the inner end of the tunnel and following the dip of the vein, two shafts or inclines have been sunk, No. 1 and No. 3, as already mentioned; these are furnished with two tracks of 56-lb. rails, and standard gauge.

The hoisting machinery is all set up in the mine at the junction of both tunnel and inclines, and consists of two engines, with cylinders 14 x 26, coupled on to the opposite ends of the shaft. Three drums, 6½ ft. in diameter, are geared to the shaft, only two of them being used, and the third kept in case of breakage.

The mine is very free from water, and whatever water there is percolates from the surface: the greater part of this drains into the tunnel, where it naturally finds an exit; what remains is caught in sumps or cavities and is pumped into the tunnel. The pump used is a Deane, with 6 in. cylinder and 10 in. stroke; the suction is 3 in., the discharge is 2 in., vertical lift, 175 ft. The water is so strongly charged with acids and copper in solution, that it is required to have the water piston and piston-rod end of the pump made of brass.

The cars are made of ¼ in. steel plate, with false bottoms of boiler iron ⅜ in.; length of car, 5½ ft.; width, 3 ft.; depth, 2½ ft.

The rope used is a 1 in. patent Lang, consisting of six strands of seven wires each and hemp centre. The strands and wires are wound in the same direction; the advantage claimed by this arrangement is that more surface is exposed to friction and consequently the wear is more uniformly spaced throughout the whole cable.

This wire rope has done excellent work, one just removed having been used for over two years without any sign of giving way.

The greatest wear is experienced in the 100 ft. next to the car, but as the rope is bought longer than at first needed, it can be cut as soon as the wear becomes apparent, the rope being still sufficiently long.

In No. 3 shaft plats are used most extensively—the six trammers who, like all the men in this mine, have to work alternately day and night shifts, and are six in number in each shaft, may be divided in 2 gangs of 3 each, occupying 2 plats. While a car is being loaded at one plat the trammers at the other plat gather the ore ready for loading, so that when the car comes down again they have but to shovel the ore directly into the car, which is not delayed more than four to six minutes.

I may here say that these cars contain 41.25 cubic ft. of ore, or about 2½ tons.

In No. 1 a faster method of loading is ensured; here, too, the trammers may be divided in two gangs, occupying two levels in which there is a track leading to the breast of work, a turntable and cradles.

The cradles having been let down at the upper level, the car is stopped, turned around and switched aside, while a full car, which was already waiting, is attached to the rope and hoisted. The empty car is now pushed to the end of the level and there loaded. The next car coming down is not allowed to stop at the upper level, but is sent down to the lower, where in the same manner a car is ready to hoist. In this way the car is not kept waiting more than 1 to 2 minutes, often less than that.

This method is not practicable where the stopes are very large and the dip variable, because it necessitates handling or "mucking" the ore too many times.

Both hand and machine drills are used—machines in the large stopes, and hand drills in small veins to clean away.

The chief methods of working are: 1st, sinking and raising; 2nd, backstoping; 3rd, underhand stoping.

Raising is done more in connection with backstoping, while sinking generally goes with underhand stope.

In backstoping, the raise will be first started up the vein with one machine, 6 ft. wide by 6 ft. high; then following it is another machine backstoping, *i. e.*, taking out the vein by successive strips either lengthwise or crosswise; this is done where the vein is not very thick, maximum 8 ft., as in the recently found hanging veins.

Underhand stoping is used where the vein is very thick, or when sinking the shaft. Generally the hanging is followed closely and then the footwall reached by underhand stoping. This last system, employed in connection with shaft sinking, is very satisfactory, as it enables two, three, or more machines to work side by side, drilling out a shaft which in this particular mine may be of the thickness and half the width of the deposit, as there are two such shafts, that is, it may be 20 to 60 ft. thick, and 70 or more feet wide.

Nine machines are used, as follows:—Three Ingersoll Seargeant, two Rand No. 3, three Rand No. 2, one Slugger. No. 3 Rand is specially good for the very hard ground which is met with in places, on account of the life of the drill, the heaviness of the blow and the positive motion of the rocker, which requires it to be sent up very seldom for *slight* repairs.

A Sullivan diamond drill, size S, is used; capacity of bore-hole is 500 ft.; diameter of hole, 1½ in.; diameter of core is 1⅛ in. This machine will drill, per day of 10 hours in copper ore, 12 ft.; in green rock, *i.e.*, trachyte, etc., 8 ft.; in quartz, 10 ft.; in the white country rock, 14 ft. The 10 hours includes the time necessary for coming down and going up the mine, so that for a continuous run of 10 hours the figures would be slightly higher. Connected to the feed pipe of the drill is a small Worthington pump, size 3 x 2 x 3 in.; this furnishes the necessary water to keep the bit from becoming heated and also to carry out all the rock pulverised or ground by the action of the diamonds.

This drill has done excellent work; this summer, by its judicious use, two large veins, as mentioned, have been exactly located. It works smoothly, whilst the time required for running back the feed and placing in a new feed or water pipe is very small.

The diamonds, if good, may last any amount of time, as they can be taken from the bit, when this is worn; but it is sometimes difficult to get such good diamonds. Both the diamond drill and the percussion drills are run by compressed air, brought from the compressor at the surface, through a 5 in. pipe, down the incline where it sub-divides into two 2 in. pipes, one of which has to supply five percussion drills with air-chest aperture less than 1 in., while the other has for its share four percussion drills and the diamond drill, whose air aperture is ¾ in.

Dualine is most extensively employed; black powder is very seldom used. Machine drill holes are fired by the battery, hand drill holes by the fuse.

Signalling, such as stopping the cars and starting them up, is done by means of a 1 in. pipe running up each incline and terminating with a syren in the engine.

At about every 50 or 100 ft., according to want, there is along the pipe a mouthpiece always kept blocked or closed except when being used at that point, and by blowing in this a sharp and very loud note is heard in the engine room.

Large timbers are used quite extensively where the walls are not firm, the main object being to keep the hanging from starting, as the miners are made to be very careful in trimming down all stuff loosened by blasting.

Poor rock may also be heaped up and kept in place by means of stulls and solid lagging.

Pillars of ore are spaced quite equally so as to allow a uniform distribution of stress, while the two shafts are separated from each other by a continuous wall of ore, broken through here and there so as to allow better circulation of air.

We now come to examine the work done by trammers and miners.

Trammers work both day and night shift, and are in all twenty-four in number—that is, six in each shaft per shift.

Six men can shovel 16 cars of fine ore of 2½ tons each, but if the ore is in large pieces or "roughs," then 20 cars can easily be put up; this corresponds to 6⅔ to 8⅓ tons per man per shift of 10 hours.

Besides loading the cars, the trammers have to wheel the ore to the platforms, where it is shovelled into the cars, to bring down the broken ore from stopes, etc.

They are paid $1.25 and $1.20 per day.

One "set up" of five or six holes of 6 ft. each, or oftener two "set up" of three holes each, is the average work done by an air drill per shift.

An 8 ft. hole may be drilled by a machine in one hour in copper, using water; if water holes are impossible the time required is greater; but it must be noted that, besides loading and blasting their own holes, the miners are required to carefully examine the roof and take down whatever has been loosened by blasting.

In hand drilling 5 to 10 ft. of drilling is considered a fair day's work for two men.

Nearly all the miners are on contract, that is, they are paid by the fathom in drifting and smaller stopes, and by the car in larger stopes.

In drifting, 5 to 6 fathoms per month, working both shifts, is the average work of a machine; this brings to the miner from $45 to $55 a fathom.

In backstoping, under the same conditions, 16 to 24 fathoms are generally broken down, paying from $10 to $18 a fathom. Eight to ten cars, bringing 60 to 70 cents a car, represents the work done by one machine in a day. Drifting by hand drilling, though little used, is paid $45 to $70 a fathom, while 8 to 12 ft. are generally broken in a month by two men working only day shift. The size of the drift is generally 6 ft. high and 5 to 6 ft. wide; the drifts drilled by machines are, in ordinary ground, a little larger, 6 to 7 ft. high and 8 ft. wide.

Miners on contract work only 9 hours a day.

Company account men are paid by the day, the miners getting $1.50 and helpers $1.25. About 100 men are employed in the mine itself, and nearly as many outside of it

The following were the expenses of running one machine, day and night shift, for a month, on a contract where the profits were shared by both miners:—

Ground drifted—5 fathoms, at $50 a fathom			$250 00
2 helpers, at $1.35, for 25 days		$67 50	
4 boxes dynamite	$50 00		
30 lbs. candle	3 75		
30 lbs. steel	4 50		
350 sharps	10 50		
4 reels wire	2 00		
250 Victor electric fuse	15 00		
		85 75	
			152 25
			$97 75

Net profit per miner per month, $48.87.

Two air compressors, one a straight line Ingersoll, 20 x 30 in. cylinder, the other a Rand compound, 14 x 22 in. cylinder, with condenser, and each of 10 to 12 drill capacity, furnish the compressed air for drilling, generally at 80 lbs. pressure.

The ore is now taken from the landing at the head of the incline by horse and hauled to the dressing shed, a distance of about 2,000 ft. The ore is there freed from poor rock and picked in different sizes.

After being dressed, the ore is carried in cars containing 9,000 lbs., by means of a gravity train, to the B. and M. siding, and is there loaded in cars for shipment.

The method of dressing the ore certainly deserves a short description.

The ore is dumped into the chute, which is 12 ft. long by 4 ft. wide, and has two screens inclined respectively 35° and 45° from the horizontal, the first screen being made of 2 x 3 in. rails 2 in. apart, the second a ¾ in. wire screen.

The ore is thus made into three sizes: all over 2 in., or roughs; all over ¾ in.; all under ¾ in., or fine. The roughs are freed from any poor stuff and broken to such a size as will suit the crusher, about 10 in.; the crusher breaks them to ¾ in. stuff and fines, which are let through a ¾ in. screen, while all the other stuff, about egg-sized, is allowed to run directly into the car below.

The pickings, or the ¾ in. stuff in the chute, are wheeled to the picking tables, where six boys are employed to separate out the copper ore by throwing it down a funnel-shaped box into the car below; while the waste rock, which is not as great in quantity as the copper ore, is put in a square box beside each boy and thence carried to the poor rock car, which is dumped over the waste pile. Fines, or stuff under ¾ in., are made into a pile to await concentration by jiggers.

The breaker is essentially a Blake, or jaw-crusher, with Gilbert frame.

The jaws are 20 x 30 in., the receiving capacity 20 x 2½ in. The number of cars hoisted is generally between 34 to 40 per 10 hours, or a maximum of 1,656 cubic ft.; and as the crusher can break, when worked at its maximum capacity, 2,700 ft. of rock per 10 hours, this leaves quite a margin to compensate time lost, etc.—all the more as the copper does not all have to go through the crusher.

The driving engine is 28 h. p. with cylinder 12 x 8 in., the engine pulley being 30 in. diameter and the crusher pulley 20 in. diameter.

The ¾ in. stuff or pickings from the chute is wheeled into a box in front of the picking table; this box is 3 ft. deep by 3 ft. wide by 12 ft. long; at 1½ ft. from the bottom is a perforated ¼ in. cast iron plate upon which the ore is dumped and floated over by a constant stream of water.

This keeps the ore wet and carries through the perforations all the dust and small stuff that might be present. One man stands at each end of this box and shovels the ore to the pickers on the table, which is slightly inclined and covered with ¼ in. steel plate. The pickers throw all the copper down a funnel-shaped box, which the table itself covers, just leaving a sufficient opening (about 4 in.) to allow the ore to pass through, while the poor rock, as already mentioned, goes to the dump.

The shed itself is built on the hillside and consists of two storeys succeeding each other along the slope of the hill, one of which is 12 ft. higher than the other.

The lower storey contains the engine, the boiler, the ore-car, and the crusher, which is built on a frame and whose feed-opening is on a level with the floor of the higher storey.

In the upper storey is the ore-chute, the pickers' table.

The shed is heated in winter by the exhaust steam of the engine, brought over the picking tables in five 4 in. pipes, 18 ft. long, connected with a 10 in. pipe of the same length placed under the pickers' bench.

The machine and blacksmith shops are situated alongside the track near the tunnel; the machinist, apart from his ordinary work, has also to set up bits for the diamond drill.

Wood is the fuel used, and costs $2.50 a cord delivered at the mine.

A few words might be said about the geology of the country. The strata in which the Eustis ore body occurs belongs to the Quebec group or division of the Huronian age, and consist of white talcose schists in which occur here and there crystals of iron pyrites sometimes more than 1 in. across, either in the form of cubes, or dodecahedrons.

The strata dip at an angle of 35°, the vein itself following the run of the strata. A little to the north of where the ore-body occurs, the white schists form a cup-shaped depression into which is laid down a later formation, the black cambrian slates, which also contain crystals of iron pyrites. They are inclined at about 75° or 80° to the horizontal, the difference of inclination between the Cambrian and pre-Cambrian being very marked.

This band of Cambrian slates is not more than 500 ft. in width, and is again succeeded by the pre-Cambrian rocks. Intruding through these, about a mile to the south of Eustis, is an intrusive mass of diorite, half a mile wide, and extending to Sherbrooke; it is remarkable for the reason that it runs parallel to the dykes which cross the ore-body.

To the south, and overlying the pre-Cambrian schists, is a Silurian limestone, which is fossiliferous.

Several dykes of diorite cross both the Eustis and Albert mines; these dykes, which are very nearly vertical, do not affect the composition of the ore in any way, except that it is slightly hardened.

Several faults have disturbed the continuity of the vein, one of which was an upthrow of 25 ft.

The origin of these deposits is not known yet to a certainty, though geologists now seem to rally to the idea of segregation from below; but apart from the researches of Santeyer there is very little known about it. There certainly is enough copper pyrites and iron pyrites in the surrounding country rock to form veins of such dimensions as the Eustis deposits.

One thing worthy of consideration is that all the deposits around Eustis, including the Capel and Albert deposits, seem to congregate along a certain line which extends as far as North Hatley, a distance of three miles.

In conclusion, it may be said that the industry of mining ought to be much encouraged, as it is one that brings great wealth to a country, and special aid to the people surrounding Eustis und Capelton, for a great many of the miners have got their small farms which they manage to keep in good order whilst working themselves in the employ of the Eustis Mining Co. and other companies.

The Lighting of Collieries by Electricity.

While there are some who openly question the expediency of applying electricity in lieu of steam or compressed air for other purposes, none appear disposed to cast doubt upon the value of electricity for lighting coal mines, both above ground and below. For this important requirement the electric light is being adopted with rapidity, and with little or no misgiving as to the result.

A recent writer on this subject has pointed out that when inventors first began to realize the commercial importance of incandescent lighting one of the most difficult problems was to produce a lamp of sufficiently high voltage to bring down the cost of conductors to a reasonable figure. Edison's discovery of the high resistance filament solved the problem, and made it possible to use a voltage of about 110 for distributing purposes. Even this was found inadequate for large areas, and he afterwards devised the three-wire system, in which two dynamos are connected in such a manner that, while the total voltage of the system is 220, the lamps, being connected to a third or neutral wire, receive only 110. By this means the voltage is doubled, and the cost of copper accordingly reduced to one-fourth, or practically, taking the central wire into consideration, to not more than three-eighths. This system is in use in nearly all large cities, both in America and in Europe. Later, attention was directed to the alternating system, which has been rapidly adopted in cases where the lighting is scattered, or where long distances have to be covered. A brief consideration of the properties of alternating currents will show why it is better adapted for this work. If the electro magnetic impulses that form an electric current be propagated continually in one direction, the current is said to be continuous, but when they alternate in direction at a more or less rapid rate, then the current is said to be alternating. The alternating current enables us to take advantage of an effect called induction, which is only exerted when the current is suddenly broken or changed in direction. Thus, if we wind two separate coils of wire on an iron bar, and pass a direct current through one coil, no effect is produced in the other coil except at the moment of turning on the current; but if an alternating current is used instead, a current is at once produced and maintained in the second coil. By a very simple law, the pressures or voltage of the two coils are in proportion to the number of turns in each. Thus, if the primary coil is supplied with current of 1,000 volts, and the secondary coil has one-tenth as many turns, the pressure in the secondary will be 100 volts. Such a device is called a transformer, and its use enables us to employ practically any voltage necessary for economy in transmission, and reduce it to a low pressure at any desired point for use in lamps or motors. The alternating-current machine may be built to give directly a pressure up to 2,000 or 3,000 volts, and in certain types as high as 5,000 volts. If this is insufficient for the purpose, the voltage may be still further increased by the use of transformers. By the proper proportion of the primary and secondary coils, the voltage may be raised to any pressure which can be safely transmitted over aerial lines.

Another recent writer has shown that by new improvements incandescent lamps of high quality can be obtained at cheap prices to work at an electric pressure of 200 to 250 volts. There are already instances where electric motors are worked successfully in collieries at pressures of 500 volts. It is almost absolutely necessary to work motors at this high pressure to save copper in the cables or mains, while 250 volts is the highest pressure at which known lamps can be used. These facts point to the necessity of using two generating plants—one to give 250 volts for the lamps, and the other to give 500 volts for the motors; or a three-wire system may be adopted, with two dynamos in series, as usually worked in municipal generating stations, with rather doubtful results. In any case, two circuits must be provided, one working at about double the pressure of the other. In laying out a plant for a colliery, these pressures must be very carefully considered, for, once placed, the pressure in a continuous-current plant is unalterable, except by the expensive process of discarding the generators, lamps, and motors, and replacing them with new ones. A pressure varying from 200 to 250 volts seems to be the best for the lamps, and the copper conductors to feed the lamps at these pressures will be only half the weight of those required for lamps at a pressure of 100 to 120 volts.

In the installation of colliery lighting plant there are two alternatives open: first, to lay down a separate engine and dynamo at the pit bottom, but this is generally impracticable; second, to fix a separate dynamo to give 220 volts and couple the lamps two in series underground. This will effect a very large saving in the cables. In an ordinary case the size of cables would be as follows:—

6 volts loss 19/15	Cost	£119
8 " " 19/16	"	96
20 " " 19/20	"	45

Usually it would also be practicable to allow the 20-volt loss, as during the night dynamo volts could be lowered by a resistance in the shunt. For fairly large underground installations it would pay to adopt this 220-volt arrangement, in spite of the fact that two dynamos would be running all through the night at extremely light loads—one for the surface and one for the underground. It is an open question whether vulcanized rubber enclosed in wood casing is the most suitable form of conductor for shaft work. There are other types of insulation and protection, such as lead covered and armored, but they are heavy, and sometimes considerable difficulty arises through not properly securing them to the sides of the shaft. This type generally costs more than vulcanized rubber. Where cables of a fairly good size have to be carried along the roadways of a mine, the armoured type is generally preferred.

There is usually a difficulty in regulating pressure at the lamp terminals below ground, unless the shaft cables are of large section compared with the load.

The size of the conductor as far as the pit bottom, which is the distributing centre, should be regulated simply with respect to the law of economy, always assuming that the cross section is not less than that of 19 strands of 16 S.W.G., which is perhaps the smallest cable worth running in deep shafts. The line drop is a secondary matter, and should be regulated as well as circumstances permit by one of the usual methods. A fair approximation can be made by the use of 105-volt lamps on the surface and 100-volt lamps below ground, if the dynamo be suitably over-compounded, and the loads on the two circuits are approximately of the same magnitude. The feeder drop is by hypothesis 10 volts, and if this be compensated for by the shape of the characteristic curve, the mean variation of pressure under the worst conditions cannot exceed 5 per cent. at any part of the two circuits. It is not likely that the dynamo would at any time run with less than about 20 per cent. of the full load, at which the terminal pressure would be, say 102 volts, and the characteristic curve could easily be flattened at from 75 per cent. to the full load, so that the maximum terminal pressure would be 107.5 volts, instead of 110 volts. The mean variation of pressure would then be about 3 per cent. With less than 20 per cent. load the pressure would diminish above ground, but below ground it would remain at approximately the proper value.

One of the earliest attempts at colliery lighting was at the Earnock colliery in Glasgow, about 15 years ago. At one of the Durham collieries, a pit was electrically lighted in or about the year 1882, and continued so for some years. The dynamo was of the old B Gramme type with a wooden hub, series-wound field magnets, and coupled in parallel, supplying current for about 50 Swan lamps of the type then called 20 c.p. The wiring was hardly done in modern style. It is true that the wires were run in casing—the casing had only one groove, which was big enough for all wires. Fuses were entirely absent, the lampholders were of the original Swan spiral spring type, and switches were considered altogether unnecessary; the engine stop valve had also to do duty for the main switch. A Paterson and Cooper permanent magnet voltmeter with a loose keeper was also fixed.

Most collieries have a fan engine with a large surplus of power, and it is often suggested that this could be used for dynamo driving, but there are very few cases in which it is advisable to do so. The average speed of a fan engine may be taken at 50, and of a dynamo at 1,000 revolutions, or a 20 to 1 ratio. This involves a countershaft and fast-and-loose pulley, or a friction clutch. This gearing, with the additional belting required, often costs almost as much as a small engine, and is not so satisfactory. Five to 10 per cent. variation in the speed of a fan is not uncommon, but this variation is far too great for electric lighting work. Again there is the uncomfortable feeling of depending on one engine for light and ventilation. A recent writer has shown that the best arrangement is to drive the dynamo with a separate engine. Usually, there is space in the fan-engine house to receive an engine and dynamo, and a more suitable place could hardly be found. The man is constantly in attendance, and is, as a rule, not overworked, and can therefore do all that is necessary for the electric-light plant. The steam consumption of a colliery electric-light engine need not, as a rule, be considered, and an ordinary belt-driven engine seems to answer the purpose. Small vertical engines running at from 200 to 250 revolutions have been found a satisfactory type.

Lamps of high voltages, 200 to 250, can now be procured commercially; they have been used for some time successfully on the Continent, where the candle-power is not less than 16 in the case of the 200-volt lamps and 25 in the case of the 250-volt lamps. There is no reason why alternating currents should not be used, at all events for the lighting of coal mines. There is also the alternative of using a pressure of 300 or 400 volts, and running the lamps in series, a system adopted with success in many cases overground.

At the Rockingham colliery of Newton, Chambers & Co., in the Yorkshire coalfield, a plant for lighting, with Swan's incandescent lamps, the shops, engine-house, pit bank, and Silkstone pit bottom, has recently been put down. A 15-horse-power single 11-inch horizontal, with 20-inch stroke, and patent cut-off, going at 129 strokes, will drive the 12 unit compound-wound Northampton dynamo; 105 volts are yielded and 2,900-candle power obtained; 64 16-candle power lamps, 16 32-candle power, two 60-candle power, and seven 200-candle power lamps are now in use. Special cut-outs are included in the circuit, in case a number of lamps are switched out at any time.

The conditions of underground lighting have been briefly summarized thus: The whole of the lighting is required during the day, but at night only a few lamps at each pit bottom or mouthing are used. During repairs, certain sections of the underground lighting may also be wanted during the night. These conditions imply that the best arrangement is to have a cable connected with the surface installation sufficiently large to supply the whole of the lighting with only a small loss, say four volts, and to use lamps of the same voltage as on the surface. To take a case which may be considered an average one, for a shaft 600 yards deep, 25 amperes will be required at the bottom with three volts loss; the cable will be [illegible] size, and, allowing 1,300 yards of 2,000 megohms vulcanized rubber, will cost £342.

Volts lost.	Cable.	£
3	[illegible]	342
4	[illegible]	310
10	[illegible]	119

If four volts the figures will be [illegible] and £310. In addition to these figures, there will, of course, be the cost of specially strong casing, and the fixing thereof, as well as the lamps and wiring underground. Taking the cost of the latter at 30s. per lamp, it will be seen that the total capital outlay required for 50 lamps will be £425. It is possible to provide for a larger loss, say 10 volts, in the shaft cable, and use, say, 110 volt lamps on the surface and 100 volt lamps underground; the cable would then be [illegible] and cost £119. Assuming that the cables are provided for a 10-volt loss at full load, and that the lamps required allnight are only 20 per cent. of the full load, it follows, of course, that when these lamps are burning the volts at the pit bottom will be 108, but as this pressure would very soon destroy the lamps, it is necessary to either switch in a resistance or to wire them in duplicate—one set for 110 volts and the other for 100 volts. There is the further inconvenience that the other lights cannot be used at all unless almost the whole lot are switched on.

Speaking generally, electric lamps should be enclosed in very strong fittings, absolutely dust-proof, and with a thick outer glass, which in some instances must be protected by a stout wire guard. In some districts the screening and cleaning arrangements are the most important part of a colliery from an electrical point of view. A liberal amount of light should always be provided, so that when the glasses become a little dusty there may still be sufficient light to detect the impurities in the coal. No general rule as to the amount of light to be provided can be laid down, as the screening arrangements vary so largely, and also the quality of coal that has to be dealt with. In South Wales, for instance, very little coal screening or picking is required, while in Leicestershire house-coal collieries the small waggons from the mine are drawn into a special shed for the purpose, and the best pieces are carefully selected and packed by hand in the railway waggons adjoining. Between these two extremes there is almost every possible variation, so that each individual case has to be dealt with on its own merits. In addition to the surface-lighting arrangements of collieries, electricity has also been extensively used underground for lighting the main roads, engine-houses, etc., close to the bottom of the shaft. Where the shafts are comparatively shallow, and the number of lamps is small, the underground lighting can be easily effected by a cable from the surface installation led down the shaft, but where the shaft is deep the cost of cables becomes serious.

Some have suggested that an alternating current might be used for lighting the pit, and a way of applying an alternating current to that purpose has been described by E. W. Cowan. The alternating current may be obtained from an ordinary continuous current dynamo, such as would be used for the surface lighting, by simply fixing two narrow collecting rings on the commutator and making electrical connection between them and opposite bars of the commutator. One pair of brushes would then supply continuous current for the surface lighting, and a second pair supply alternating current to the pit shaft. At the top of the shaft a transformer would be fixed, transforming the 70 volts of the alternating current up to, say, 1,000 volts. The supply might be carried to the pit bottom by means of a $\frac{7}{10}$ lead-covered concentric table, cleated to the woodwork in the shaft. At the bottom the current would be transformed down again to the pressure required for the lamps. The cost of this arrangement has been calculated at £147. There would, of course, be some loss of efficiency, due to the iron loss in the transformers. In the case taken it would amount to 198 watts, say, three 60-watt lamps, but this is not a serious matter where coal is so cheap. There are two objections which might be raised—one is the fluctuation in the light due to the low frequency necessarily resulting from using a two-pole machine as generator, but a frequency of 20 or 25 would cause no inconvenience in a mine. The other objection is the danger to workmen on account of the high pressure, but by using a concentric cable and earthing the "outer," there need be no fear on that account. As a further precaution, the end of the primary composing the layers wound round next to the secondary coils should be connected to the earthed outer. The "inner" would then be practically sealed from end to end.

COMPANIES.

Dominion Coal Co., Ltd.—At the annual meeting of the shareholders of this company held in Boston this month the following report, reviewing operations for the year ended 29th February last, was submitted:—

"As will appear from the treasurer's statement appended hereto, the output for 1895 was less by 135,633 tons than for the previous year. This was due partly to the dullness of trade in Canada and to the unusually large stocks of coal carried over by consumers, and partly to the very low price for coal prevailing in the United States.

The construction of the railway begun in May, 1897, was not completed for shipment from Louisburg until October, 1895. As the interest on its cost was charged during progress to working expenses, an amount of $51,385.51, being interest at the rate of five per cent. on this cost to the completion of the road, has been transferred from the railway suspense account, leaving to the credit of this account a balance of $125,000 to meet future railway extensions and renewals.

The falling off in sales made necessary the cancellation, at a considerable loss to the company, of several steamer charters made in 1894, in anticipation of an average season's business. Although the business to the United States was done at little or no profit, it was thought best to sell a certain quantity, mainly to the railroads, for the purpose of establishing a market which might be of value under better conditions.

The railway to Louisburg is now finished, and the company is realizing the advantage of it in largely increased business and reduced rates of freight.

The outlook for 1896 is quite good, the contracts already made ensuring an output in excess of that for any previous year. The largest ratio of increase will be in business to the United States under conditions more favorable than heretofore. The quantity which this company can hope to sell, compared with the total of six million tons of bituminous coal consumed in New England, is very small indeed; but the addition of only a few hundred thousand tons means very much to the Dominion Coal Company.

As all the mines are now equipped with modern machinery and the railways and piers completed, no construction work is being done nor is contemplated. Some additions to motive power and rolling stock may be necessary if the business increases, which it is hoped will be the case.

Various purchases of property and the usual excess over estimates in closing up large construction operations have left the company in debt for construction work some three hundred thousand dollars. Furthermore, no provision had heretofore been made for supplies, stores, and necessary working capital.

We find that bills payable to the amount of $523,000 represents what is needed to clear off liabilities for construction work, and leave some money for supplies, etc.; and deeming it unwise to carry this as a floating debt, the directors have decided to issue $500,000 of the preferred stock left in the treasury for such purpose, and have sold and received payment for the whole of this at ninety-one dollars net per share. The right has been reserved, of which notice is hereby given, to holders of preferred and common stock of record June 1, 1896, to take one share of the said stock at the above-named price, for every thirty-three shares of common or preferred stock held by them respectively, on giving notice in writing to the treasurer on or before June 15, 1896.

It may interest shareholders to know that the company owns and operates between its mines and shipping places 54 miles of standard gauge lines and 22 miles of sidings, with 13 locomotives and 1,179 cars of 10,854 tons coal capacity. It also owns and uses as supplementary to these, narrow gauge lines 18 miles in length, with 6 locomotives and 350 cars. Its passenger and general freight business is satisfactory.

Shipments for the three months ending May 31 show an increase of 69,489 tons over the corresponding period last year."

The following is excerpted from the statement of the treasurer:—

Proceeds 884,904 tons, less mining, transportation, royalty, etc.			$187,255 67
Profits on steamships, railways, barges, etc			171,392 41
Transfer from Railway Suspense account to meet accrued interest on cost construction of railway, previously charged to current expenses.			51,385 51
			$410,033 59
Less			
General expenses		$ 66,811 52	
Interest on bonds	$180,000 00		
Less accrued interest on bonds sold	11,437 45	168,562 55	235,374 07
			$174,659 52
Less accounts and interest due on above business			24,845 34
			$149,814 18
Surplus from 1894			27,613 94
Less			$177,428 12
Sinking fund		$ 32,635 88	
Dividend on preferred stock paid		100,000 00	
" " " to be paid		20,000 00	152,635 88
			$ 24,792 24
Add			
Cash received on account railway subsidy			105,808 00
			$130,600 24
Carried to			
Railway Suspense account		$112,385 51	
Surplus		18,214 73	
			$130,600 24

BALANCES FEBRUARY 29, 1896.

Assets.

Property		$19,930,406 37
Cash assets:		
Cash in banks and offices	$ 34,847 20	
Accounts and bills receivable	60,675 68	
Balances due from agents, and coal at distributing points	80,717 88	
New supplies in warehouse and stores	123,256 36	
Cash in New England Trust Co. to meet outstanding coupons	90,690 00	
" " " for sinking fund	44,814 97	
" " " for special deposit	1,163 50	
Cash in American Loan & Trust Co. for uncalled-for dividends	1,248 00	437,413 59
		$20,367,819 96

Liabilities.

Capital stock, common	$15,000,000 00	
" preferred	1,500,000 00	
First mortgage bonds	3,000,000 00	
Bills payable	523,744 80	
Unpaid coupons	90,690 00	
Dividends unpaid	1,248 00	
Sinking fund, 1895	32,635 88	
Dividend, two months	20,000 00	
Royalty	31,441 21	
Interest and accounts payable	24,845 34	
Subsidy suspense for railroad	125,000 00	
Balance to general surplus	18,214 73	
		$20,367,819 96

Van Anda Copper and Gold Company.—Registered 6th May, 1896, to carry on mining in British Columbia. Head office: Seattle, Wash. Authorized capital, $5,000,000.

Bunker Hill and Blackwood Mining Company has been incorporated with an authorized capital of $500,000 Head office: Vancouver, B.C. Directors: Ernest E. Evans, C. P. Dunbar, Osborne Plunkett, and M. M. Campbell. Formed to acquire and work the Mineral Claims Bunker Hill No. 2 and Blackwood, situate on the North Fork of Lenon creek, in the Slocan mining district, and province of British Columbia, or any part of the same, and to pay for the same either in cash or fully paid up stock of the company, or in bonds, shares, stock and securities of this or any company or corporation.

Freeburn Gold Mining Co., Ltd., has been incorporated to acquire mining claims within the Trail Creek Mining Division, B.C., and known as the "Freeburn," and to pay for the same either with money or fully paid up shares in the company.

Authorized capital, $500 0. Directors: John Irving, William Wilson and L. Goodacre. Head office: Victoria, B.C.

Georgia Gold Mining Co., Ltd., has been incorporated to purchase the Georgia mineral claim in the district of West Kootenay, B.C., and to carry on mining in British Columbia. Authorized capital, $1,000,000. Directors: Hedley H. R. Chapman, J. L. Warner and Joshua Davis. Head office: Victoria, B.C.

Victor Gold Saving Machinery Co. has been formed in British Columbia to sell the Victor gold saving machine. Authorized capital, $50,000. Directors: Chas. S. Douglas, George L. Allan, and Alexander Bethune, of Vancouver. Head office: Vancouver, B.C.

Jumbo Gold Mining Co., Ltd. Registered 7th May, 1896. Head office: Spokane, Wash. Authorized capital, $500,000. Formed to operate the Jumbo claim in the Trail Creek division, British Columbia.

Rambler and Cariboo Consolidated Gold and Silver Mining Co., Ltd. Registered 20th May, 1896. Head office: Spokane. Authorized capital, $1,000,000. To carry on mining in British Columbia.

Lily May Mining and Smelting Co., Ltd. Registered 13th May, 1896. Authorized capital, $500,000. Head office: Spokane. Formed to carry on mining in British Columbia.

Consol Gold Mining Co. Registered 27th May, 1896. Head office: Spokane. Authorized capital, $1,000,000. To carry on mining in British Columbia.

Camp-Bird Gold Mining Co. Registered 27th May, 1896. Head office, Spokane. Authorized capital, $1,000,000, to carry on mining in British Columbia.

Bean Pot Gold Mining Co., Ltd. Registered 23rd May, 1896. Head office: Spokane. Authorized capital, $500,000. To carry on mining in British Columbia.

Buffalo Gold Mining Co. Registered 22nd May, 1896. Head office: Spokane. Authorized capital, $500,000. To carry on mining in British Columbia.

British Columbia Mining and Development Syndicate has been incorporated to carry on mining in the Trail Creek division of British Columbia and elsewhere in that province. Head office: Rossland, B.C. Authorized capital, $2,000,000. Directors: L. W. Curtis, James K. Clarke, P. J. Shields, L. Beaupre, all of Rossland, B.C., and E. J. McClintock, E. B. Wiggins, of Saginaw, Mich., and Chas. E. Sheldon, of Red Wing, State of Minnesota.

Beaver Gold Mining Co., Ltd. Registered 28th May, 1896. Authorized capital, $750,000. Head office: Spokane. To carry on mining in British Columbia.

Gold Stream Mining Co. Registered 30th May, 1896. Head office: Cudahy, State of Wisconsin, U.S.A. Authorized capital, $1,000,000. To carry on mining in British Columbia.

Crown Point Gold Mining Co. Registered 30th May, 1896. Head office: Spokane. Authorized capital, $1,000,000. To carry on mining in British Columbia.

British Columbia School of Mines, Ltd., is being incorporated with an authorized capital of $30,000, in shares of $100, to give theoretical and practical training to men interested in or desiring to follow the profession or calling of the mining engineer, the assayer, metallurgist and the chemist, and to provide for prospectors, mine foremen and others interested in the discovery and winning of minerals, such instruction as shall make their occupations more interesting and profitable and less liable to failure. To purchase or otherwise acquire the business of assaying and sampling ores and giving instruction to pupils, now carried on by G. F. Moncton and A. J. Colquhoun, in the Whetham block on Cordova street, in the city of Vancouver, and to pay for the same at such price as may be agreed upon. The trustees are: R. B. Ellis, A W. Sullivan, Otto Marstrand, Charles Nelson, Thos. H. Tracey, G. F. Moncton, and A. J. Colquhoun.

Hansard Gold and Copper Mining Company. Head office: Nelson, B.C. Authorized capital, $1,000,000. Directors: Robert Shell, F. W. Swannell and Martin O'Reilly, all of Nelson, B.C. To carry on mining in British Columbia.

Mayflower Gold Mining Co., Ltd. Registered 3rd June, 1896. Authorized capital, $1,000,000. Head office: Spokane. To carry on mining in British Columbia.

Wolverine Gold Mining Co. has been incorporated to acquire mining claims and carry on mining in British Columbia. Authorized capital, $500,000. Head office: Trail, B.C. Directors: E. S. Topping, L. C. Crawford, Joseph C. Bishop, and Ralph White.

The Monarch Gold Mining Co., Ltd. Registered 30th May, 1896. Authorized capital, $750,000. Head office: Northport, Stevens County, Wash. To carry on mining in British Columbia.

Republic Gold Mining Co., Ltd. Registered 30th May, 1896. Authorized capital, $750,000. Head office: Spokane, Wash. To carry on mining in British Columbia.

Blue Bird Mining Co., Ltd. Registered 1st June, 1896. Head office: Spokane. Authorized capital, $600,000. To carry on mining in British Columbia.

Mineral Hill Gold Mining Co. of Alberni, Ltd., has been incorporated to acquire and work the Standard, Daisy, Queen of Diamonds, Lucky Boy, and Northern Light mineral claims, situate in the district of Alberni, Vancouver Island. Authorized capital, $750,000. Directors: A. A. Davidson, Victoria; W. A. Dier, Victoria; Lawrence Goodacre, Victoria, and W. K. Leighton, Nanaimo. Head office: Victoria, B.C.

Hattie Brown Gold Mining Co., Ltd. Registered 28th May, 1896. Head office, Spokane. Authorized capital, $1,000,000. To carry on mining in British Columbia.

Palo Alto Gold Mining Co., Ltd., has been incorporated to acquire and work the Palo Alto mineral claims in the West Kootenay district, British Columbia. Authorized capital, $1,000,000. Directors: D. W. Higgins, Victoria; W. H. Ellis, Victoria; T. H. Prosser, Victoria; W. C. Estep, Spokane, and P. A. O'Farrell, Spokane. Head office: Victoria, B.C.

Pittsburg and Cariboo Gold Dredging Co. Registered 10th April, 1896. Subscribed capital, $500. Head office: Pittsburg. Formed for the purpose of dredging gold, silver and other minerals in the Fraser river and its tributaries in British Columbia.

Allison Ranch Hydraulic Mining Co., Ltd., has been incorporated to acquire placer mining claims, leases, water rights and property, held by C. R. Townley, trustee, situate at the junction of the Tullameen and Similkameen rivers in the Yale district, British Columbia, and to carry on mining in that province. Authorized capital, $250,000, in shares of $5 each. Directors: Capt. H. R. Jones and T. O. Townley, of Vancover, and F. J. Coulthard, of New Westminster, B.C. Head office: New Westminster, B.C.

St. Mary Mining Co., Ltd. Registered 11th May, 1896. Head office: Spokane. Authorized capital, $500,000. Formed to carry on mining in British Columbia.

Knight Templar Gold Mining Co., Ltd. Registered 2nd May, 1896. Head office: Spokane. Authorized capital, $500,000. To carry on mining in British Columbia.

Commander Mining and Smelting Co., Ltd. Registered 16th May, 1896. Authorized capital, $500,000. Head office: Spokane. Formed to carry on mining in British Columbia.

Morrison Gold Mining Co.—Registered 30th May, 1896. Authorized capital, $1,000,000. Head office: Spokane, Wash. Formed to carry on mining in British Columbia.

Wonderful Group Mining Co.—Registered 5th June, 1896. Authorized capital, $1,000,000. Head office: Spokane. To carry on mining in British Columbia.

The San Joaquin Gold Mining Co. has been incorporated to acquire the San Joaquin mineral claim, West Kootenay, B.C. Authorized capital, $1,000,000. Directors: Hon. E. Dewdney, D. W. Higgins, and A. J. McLellan. Head office: Victoria.

Monte Cristo Gold Mining Co., Ltd.—Registered 30th June, 1896. Authorized capital, $1,000,000. Head office: Spokane. To carry on mining in British Columbia.

Epps, Dodds & Company, Ltd., is applying for incorporation in New Brunswick for the purpose of mining and quarrying granite and other stone. Capital, $15,000, in shares of $100. Head office: St. George, Charlotte Co., N.B. Directors: C. A. Epps, James Dodds, and Henry Meating.

Drury Nickel Mining and Manufacturing Co., Ltd., is applying for incorporation under Ontario statutes to carry on the business of mining and smelting in that Province. Authorized capital, $1,000,000, in shares of $10.00. Directors: Thos. Kiely, Wm. Fennell, Thos. Travers, John Lawson, Moffat Lawson, John Dewyer and R. P. Travers. The operations of the company are to be carried on in the township of Drury, Algoma district, Ontario. P. O. address: Worthington, Ont.

Le Roi Mining and Smelting Co.—At the regular monthly meeting of the Le Roi Mining and Smelting Company in Spokane on June 2, a dividend of 5 cents per share, aggregating $25,000, was declared. This makes a total of $175,000 paid in dividends since last October, or at the rate of $25,000 per month. Besides doing this, the company has in the same period of time done an enormous amount of dead work, including the sinking of a new double compartment shaft, and has expended nearly $50,000 in the purchase of new machinery.

The Invicta Gold Mines, Ltd., has been registered in London, Eng., with an authorized capital of £100,000 stg., in shares of £1 stg., of which 15,000 shares are set aside for working capital. Directors: Edward Rawlings, John W. Harker, Richard Pearce, and A. E. Walton. Head office: F. J. Warner, 25 Abchurch-lane, London, E.C.

The company has acquired and commenced working upon the following gold mining claims, viz.:—Ah Chow, Jerome Stanley Evans, Schröder, Fun Yei, Ah Yow, Wing Kei, Goo Quong, San Qui, Perseverance, and Griffiths, together with extensive water rights situated on the Wild Horse creek, British Columbia, and held direct from the Government of that Province.

The "Wild Horse Creek" is well known for the richness of its gold placers. In a work on "British Columbia: Its Present Resources and Future Possibilities," published in 1893 by direction of the Provincial Government, it is estimated that gold to the value of $10,000,000 has been obtained therefrom.

The property acquired by the company comprises a continuous bank of auriferous gravel, about a mile in length, estimated to contain at least 20,000,000 cubic yards of gravel. The value of this gravel, taken on the basis of the past workings, should produce from twopence to two shillings and upwards per cubic yard.

Large amounts were expended, before the purchase of the property by this company, for the establishment of dams, ditches, water-flumes, pipes, sluices, buildings,

&c., which will be available for future working. The main ditch, 4½ miles in length, is capable of delivering 1,000 miner's inches of water per day, at a height of 400 ft. above the lowest level of the gravel bank.

A special feature is that the water rights practically command the water supply of the whole creek.

It is intended that the company shall carry on operations on an extensive scale by enlarging the main ditch to a capacity of 2,000 miner's inches of water per day, and providing a further complete and powerful hydraulic plant of the most approved pattern, which will enable the natural advantages of the property to be utilized to the fullest extent, and the separation of the gold from the gravel to be effected in the most economical manner. It is also intended to erect further electric lighting plant, which can easily be worked by water power, so that operations may be carried on night and day.

Estimates of the cost of efficiently equipping the mine have been prepared for the vendor by Mr. A. K. Beatson, an experienced Californian hydraulic engineer, who has for the last two seasons superintended the workings hitherto carried out.

Mr Beatson is of opinion that, when the mine is equipped as proposed, at least 4,000 cubic yards of gravel can be treated per day of 24 hours, from which he estimates a net return of gold of at least 12 cents (equal to sixpence) per yard. Such an output, say over 700,000 cubic yards in a working season, at the above estimated yield, should give handsome dividends to the shareholders.

It is well known that hydraulic mining is the cheapest form of mining. No expensive machinery is required, and the operation of extracting the gold involves a comparatively small cost for labor and works. Experience on California mines has proved that gravel yielding only 5 cents of gold (equal to twopence) per cubic yard can be worked at a profit. With the area of gravel to be worked, and with the natural advantages which exist on this property, there appears to be every prospect of a profitable future for the company.

Sufficient working capital has been provided for the necessary machinery and for executing the proposed new works.

In addition to the auriferous gravel banks referred to, it is believed that a "deep lead," or channel, exists at a depth of from 30 to 40 ft. below the present workings, similar to the "deep leads" of California, which have proved to be so phenomenally rich. It is impossible to determine at present the value of the deposit which may be found in such a channel, but it would probably be safe to estimate it as richer than that of the bank now exposed. At a comparatively small cost a shaft could be sunk at a point which has been indicated by Mr. Beatson, and a tunnel run east and west, cross-cutting the channel, from which the "deep lead" gravel could be worked by means of hydraulic elevators, ample power for working which exists on the property. It is intended to prove this "deep lead," as its existence may add largely to the revenue of the company.

There is an abundance of timber on the property available for mining purposes, and labor can be obtained at moderate rates.

The above statements are based upon the report of Mr. J. A. Skertchley, F.R.G.S., C. and M.E., and Mr. Beatson, supplied by the vendor to the directors.

Since the company acquired possession of the property Mr. A. D. Mitchell has been installed as manager and has reported very favorably to the directors thereon.

Operations have already been commenced, having for their object the immediate resumption of working with the existing plant, pending the completion of the additional works.

Kootenay Mine Exploration Co., Ltd., seeks incorporation with a capital of $200,000, in 40,000 shares of $5. To carry on mining in the Kootenay district, B.C. Directors: G. Gooderham, Toronto; R. H. Pope, M.P., Village of Cookshire, Que.; T. G. Blackstock, Toronto; J. W. Beatty, Toronto; D. Fasker, Toronto.

The Beatty Gold Dredging and Mining Co., Ltd., seeks incorporation with a capital of $50,000, in 500 shares of $100 each for the following purposes: To acquire from M. Beatty & Sons, of Welland, Ont., the lease of the Boston Bar on the Fraser river, near North Bend, in the Province of British Columbia, together with a dredging plant to operate under said lease. To mine for gold and other minerals, and generally to carry on the business of mining for gold and other minerals. Chief place of business in Yale district, B.C. Directors. W. L. Beatty, H. Le G. Beatty, A. O. Beatty, of Welland; H. C. Symmes, Niagara Falls; H. F. McSloy, St. Catherines, Ont.

The Windsor Salt Co., Ltd., seeks incorporation with a capital of $200,000, in 2,000 shares of $100, with the following objects:— To mine, manufacture and purchase and sell salt in the Dominion of Canada. Directors: Sir Wm. Van Horne, K.C.M.G., Montreal; E. G. Henderson, Windsor; R. F. Sutherland, Windsor; John Morrow, Montreal; Jas. Sutherland, Montreal.

Ontario Miners' Development Co., Ltd., has been incorporated. Authorized capital, $150,000, in shares of $5. Directors: James Connell and G. O. Clavette, Port Arthur; John Flets, Hume B. Proudfoot, A. Wilson and J. Van Sommer, Toronto; H. N. Kitson, Hamilton, Ont. Head office: Toronto. Formed to acquire and work mineral lands and mines in Ontario.

Wallaceburg Gas and Oil Co., Ltd., has been incorporated with an authorized capital of $40,000, in shares of $50 each, to bore for natural gas and petroleum in Ontario. The operations of the company are to be carried on in the townships of Dover, Chatham Sombra and the town of Wallaceburg. Directors. D. A. Gordon, John Cooper and J. W. Steinhoff.

Dominion Gold Mining & Reduction Co.—At special meetings of shareholders of the Company, held on the 21st ulto, the resolutions for converting the priority shares into ordinary, and increasing the capital, passed at meetings on the 4th ulto, were confirmed.

The London and British Columbia Goldfields, Ltd., was registered on the 16th ulto., with a capital of £200,000 in £1 shares (£2,500 being deferred shares), to deal with mining, land and other properties in British Columbia and elsewhere

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Seine River Gold Mines Co., Ltd., has been registered in London Eng. with an authorized capital of £100,000, in shares of £1, to acquire and work the Kelly-Mosher gold claims in the Rainy Lake district, Ont. Development is proceeding.

American Gold Mining Company is the name of a new syndicate formed to acquire and work the Swede Boys claim on Manitou Lake, Ontario. The property comprises location H. P. 304, 384 and 385, and contains about 250 acres.

Byron N. White Co.—This Company operating the Silver Star, silver-lead mine in the Kootenay district, B.C., is reported to have recently paid a cash dividend of $100,000, or 10 cents per share on its stock of 1,000,000. This represents only the cash put aside from the winter's work, and does not represent the entire profit of the mine during the period mentioned. Nearly $125,000 was expended from the profits in building the concentrator, just put in operation, and in other improvements. The mine is now at work filling a contract with the Omaha & Grant smelter, calling for 1,500 tons per month for a period of 8 months. From the *Spokesman Review* we take the following: "The Slocan Star is one of the most remarkable mines in the northwest. When the property came into the hands of Mr. White it was scarcely more than a prospect, but developed wonderfully in a short space of time until now it is probably the biggest producer of silver-lead in North America. With the present workings there is now not less than $3,000,000 in sight, besides 20,000 tons of ore on the dump awaiting concentration. The management of the mine has been most conservative, and but few of the plans have reached the public. Since starting in with regular shipments about two years ago the Company has shipped 10,000,000 pounds of lead and 5,000,000 ounces of silver. It was only recently that the Company contracted to deliver 1500 tons of ore and concentartes each month to the Omaha & Grant smelters at Pueblo, Col., for the eight months commencing May 1. As this product will run $100 a ton, this contract alone means $1,200,000 at a conservative estimate.

War Eagle Gold Mining Co.—At a meeting of the shareholders of the War Eagle Mining Company held this month at its Spokane office the trustees appointed the following gentlemen as officers for the ensuing year: Patrick Clark, president; John A. Finch, vice-president; F. E. Lucas, secretary, and Austin Corbin, treasurer. At this meeting an agreement was entered into with D. C. Corbin whereby he holds an option on the property at a stipulated price of $800,000. The terms of this agreement are as follows: Mr. Corbin is to pay $800,000 in six equal payments, the first to be made on or before June 18th. He is also to erect a smelter to co-t not less than $100,000 and to expend the sum $100,000 in improvements and developing the mine. Mr. Corbin also agrees to form a new company and give to the present owners one-fifth of the shares of the new concern. If the first payment is not made by June 18th the option is void.

Considering that the present company paid about $30,000 for a group of claims—any one of which is of equal value with the War Eagle, the present deal is certainly the largest that has thus far taken place in Trail Creek.

MINING IN BRITISH COLUMBIA.

(From our Correspondents.)

Trail Creek District.

The details of the deal clearing up the title to the Gray Eagle, Exchequer and Kruger claims, situated on the Colville reservation, just across the international boundary line in the neighboring state of Washington, are now at hand. These claims cover ground also claimed by the Reservation Mining and Milling Co. Peter Porter, in the interest of a Rossland syndicate, first obtained an option on the controlling interest of the stock of this company, and then set to work to buy out the titles of the above mentioned claims. Their title hinged on Judge Hanford's decision declaring that the reservation has been open to mineral entry since 1892. The holders of the Exchequer and other claims did not make their locations until after the passage of the bill declaring the reservation open last February. Mr. Porter has succeeded in obtaining a nine months' bond for $40,000 on this group. Ten per cent. of this money was paid down; $16,000 more will be paid in four months' time, while the balance comes due next March. By this deal Mr. Porter has cleared away all obstacles to the rapid development of what is considered by expert mining men to be the best piece of property yet found on the reservation. The ledge is a mammoth one and has a colossal outcrop. The ore is an iron, copper and lead sulphide, and at places shows up fully six feet of high grade silver ore. The combined values of the lead, gold, silver and copper in the clean ore streak will average $100 per ton. At present miners are at work in a crosscut tunnel that will cut the vein diagonally at a depth of 300 feet. This tunnel is now in 60 feet. It will require to be driven 300 feet further before the true extent of the vein can be accurately determined. Mr. Porter says that a contract for this work will be let in a few days, and that three shifts, of eight hours each, will be put on.

The View, which adjoins the St. Elmo and Con. St. Elmo on the north, has just been sold to the British Columbia syndicate for $6,000 cash. Messrs. John A. Finch and Newton Campbell were the vendors. This claim prospects very well on the surface, and shows up considerable ore of a very fair grade. Its is the intention of the new owners to begin development work at once.

The Iron Dyke and Granite No. 2 are two claims that have just been taken up by the syndicate subscription plan in Spokane. The claims are situated two miles east of Rossland, and are on the line of the Trail Creek wagon road. The line of the Columbia River and Western Ry. cuts through the claims, as also does the survey of the projected C. P. R. line from Rossland to Robson. They are both full claims. On the Iron Dyke there is a vein with a large outcrop. It has the usual north-east and south-west course of all the principal sulphide ore veins of the camp, with a decided dip to the north. The capping has been broken through in places and shows a streak of iron sulphide ore in a quartz gangue. Assays from this ore have given a gold value of $7 per ton. On the Granite there is a white quartz vein running nearly north and south, in which there is considerable galena and some free gold present. Very little work has been done on either claim, but they certainly show exceptional promise.

The new machinery, lately ordered from the Ingersoll Rock Drill Co., by the Josie company, has arrived at the mine, is in place, and running to perfection. Two air drills are already at work in the mine, one in the face of the main tunnel, the other on the stopes. The showing in the breast of the tunnel is reported to be a mass of solid sulphide ore, of the best value of any ore yet extracted. The showing in the shaft on the north vein continues excellent, there being fully five feet of solid high grade ore. The old shaft at the mouth of the tunnel has been pumped out. This shaft is down 45 feet, and has a fine showing. Within the next few days a "slugger" drill will be put to work on this shaft, and work will be kept up night and day. The daily shipments from the mine have been increased slightly, though the execrable state of the roads caused by the recent rains is seriously hindering large shipments.

Messrs. Harris and Watson, who hold the bond on the Lily May, the pioneer location of the camp, made their second payment of $8000 on the 8th inst. They say that the property has a most excellent appearance, and is materially improving with development work. The connection between the shaft and the tunnel has been made, and miners are again at work in the shaft, which is now down some 20 feet below the level of the tunnel. The bottom of this shaft is in solid ore, which assays most satisfactorily. The management has just put a third shift to work on this shaft. Everything is being rushed at the mine, as the company is making preparations for the installation of adequate machinery.

There are five carloads of machinery at Northport, billed to the Trail Mining Co., Rossland. This is the 30-drill Ingersoll compressor plant that will be placed on the Columbia and Kootenay properties. The machinery, boilers and all, has been unbolted and taken apart. Martin King, the managing director, is expected to arrive any night now from Chicago. This plant, it is confidently hoped, will be in operation by the 15th prox.

The cross-cut tunnel on the Crown Point is being rapidly pushed by the contractors and is already many feet underground. It will take nearly six months of steady work before this tunnel reaches the point where it is expected that the ore chute should be encountered. This tunnel means much for the future development of the south belt, and if it satisfactorily proves the existence of the ore bodies in this section at a depth of 200 feet, the price of surrounding property will be greatly enhanced. At present nine men are at work building a wagon road that will connect the mine with the main line of the Columbia River and Western railroad. The engineers have surveyed a first-class road, a uniform grade being established the entire distance. It will only be a mile in length, and should be completed within the next ten or twelve days. There are at least twelve hundred tons of shipping ore on the dump. This ore will be shipped at once.

Since my last writing, the line of the Columbia River and Western Ry. has been completed to the town of Rossland, and now Rossland has two trains a day from Trail. The line has not been completed to the LeRoi mine yet, but it is confidently expected that ore hauling will commence before the 20th inst. There are no bridges or other obstacles in the way of rapid tracklaying to be encountered. F. A. Heinze, the owner and promoter of this road, was in Rossland during the past week. When asked regarding his intention of constructing this road to the west during the coming summer, Mr. Heinze was inclined to be reticent. However, in company with Chester Glass, of Spokane, he left for the East on Thursday, presumably in connection with the securing of funds for the rapid construction of the Columbia River and Western into the Boundary Creek camp during the coming summer and fall.

Since my last writing the Le Roi Mining and Smelting Co. have declared another dividend of 5 cents per share, or $25,000. This makes a total of $175,000 in dividends paid by this company since last October. The mine is in splendid shape and everything is now in readiness for the output of a large quantity of ore during the balance of the year. It is estimated that this company has nearly 10,000 tons of high grade ore on the dump, awaiting transportation to the Trail smelter.

The truth of the many conflicting reports anent the sale of the three most famous of the Trail Creek mines is as follows:—At a meeting of the directors of the War Eagle and Iron Mask Gold Mining Companies, held on the 20th of May last, in Spokane, an option, expiring on the 1st day of August next, was voted in favor of D. C. Corbin, President of the Spokane and Northern Railway Co., for the purchase of both properties for $1,500,000 cash, being $1,000,000 for the War Eagle, and $500,000 for the Iron Mask. It is almost a foregone conclusion that the deal will be made, as Mr. Corbin is now extending his line from Northport to Rossland. Both mines will be operated in conjunction with the railroad. Both properties are showing up remarkably well, and are daily shipping all ore extracted in development work. The Iron Mask management has just started a large shaft, at the mouth of the tunnel on Centre Star creek. At a depth of 25 ft. there is 3 ft. of solid ore on the hanging-wall that will average $60 in gold and 10 per cent. in copper. It is the richest, uniformly, of any ore yet uncovered in Trail Creek.

May has been a month for deals of magnitude in mines and prospects of the Trail Creek camp. In addition to the sale of the War Eagle and Iron Mask, the following properties have changed hands at the prices mentioned after them:—City of Spokane, $65,000; Colonna, $40,000; Iron Horse, $25,000; Enterprise, $25,000; Red Mountain, $16,000; Curlew, $7,000; Camp Bird and Consolation, $8,000; San Joaquin, $5,000; St. Paul, $3,000; View, $6,000. Many smaller sales have been made, but these are the most important.

Development work in the south belt continues apace, and every property that is having any work done on it has stood the ordeal wonderfully well. At the Lily May a connection has been made between the tunnel and the shaft, and now there is a good supply of pure air, which greatly facilitates development work. Miners have been put to work again in the shaft, and now at a depth of 80 ft. it shows up a solid bottom of ore, which the owners say averages wonderfully well both in gold and copper. Thirteen men are at work on this property.

The machinery formerly installed at the R. E. Lee mine has been bought by the Commander Mining and Smelting Co., and placed on the Commander mine. The plant consists of a hoist, sinking pump, and two steam drills. The shaft has been sunk 30 ft since the present company took hold, and the superintendent informs your correspondent that the mine never had such an encouraging appearance. There is a large shaft full of high grade gold and copper ore. It is the intention of the management to ship what ore has been taken out (about 60 tons). Drifts will be run each way from the 100 ft. level.

There have been no material changes in the prices of Trail Creek's stocks during the month. Monte Cristo and Crown Point are among the many that have made their appearance during the month, and are selling well. A feature of the market was the offer of a small block of LeRoi (120 shares). It was quickly taken and brought $5.60 per share. Speculation in War Eagle and Iron Mask is very quiet on account of the option to Corbin. Josie and Poorman continue to be about the best speculative stocks on the market. They are both looking extremely well and are shipping ore.

[NOTE.—No stocks are listed in this table unless the property on which they are founded has been fully paid for and the title perfected.]

Quotations corrected weekly by Reddin & Jackson, Mining Brokers, Rossland, B.C.

Caledonia Con	.06	Mayflower	.16
Crown Point	.20	Monte Cristo	.19
Deer Park	.07½	O. K.	.34
Evening Star	.16	Paris Belle	.09
Georgia	—	Phœnix	.10
Gertrude	.10	Poorman	.13½
Great Western	.15	Silverine	.10
High Ore	.09	St. Elmo	.14
Iron Mask	.77½	Virginia	.30
Josie	.55	War Eagle	1.75
Jumbo	1.10	West Le Roi	.16

No Le Roi, Centre Star, Idaho, or Trail Mining Co. on the market.

Boundary Creek.

John Weir, who bonded the "Copper" claim, Copper camp, and the "No. 7," White's camp, has since bonded the two extensions of the "No. 7,"—the "Rob Roy" and "Falcon." The old shaft on the "No. 7" is being cleaned out and timbered, and in a few days a contract will be let for its continuation. The two-foot vein on this property can be traced through the three full claims, and in the shaft on the "Falcon" shows ore almost identical with that in the "No. 7" shaft.

A contract has been let for a hundred-foot shaft on the "Copper." The shaft is being sunk vertically at the contact of the ore body and the porphyry, and, considering the dip of the vein, the shaft, it is expected, will be in about the centre of the ore body at that level. When this level is reached drifting and cross-cutting will be commenced, at once and pushed with all possible speed, as the holders have only a six months' bond on the property. The shaft is now down about 26 ft.

The "Oro Dinero" in Summit camp has been bonded to John M. Burke for $30,000, and it is understood, by him again to Ross Thompson, of Rossland. Considerable surface development has been done, but no depth as yet has been attained. The ore is chalcopyrite, carrying silver and some gold.

The "R. Bell" group of claims in Summit camp is bonded by Mr. Hanley, (superintendent of the Old Dominion mine) it is understood, for Salt Lake parties. The bond is said to be for $12,000, but the amount is not really known at present. The "R. Bell" claim was located last fall and is the direct extension of the "Cordick," owned by Capt. R. C. Adams. The chalcopyrite carries a high value in silver.

The shaft being sunk at the end of the long cross-cut tunnel on "Gold Drop," Greenwood camp, on the hanging wall side, is down some 60 ft. The ore is becoming higher grade; the gold value being now $12 to $19 per ton. The diamond drill has been moved on the "Snowshoe" from the lower to the upper vein.

It is known that a ten days' option has just been given on the "Winnipeg," but neither the amount nor the parties interested can be learned. This is the claim, it will be remembered, which was bonded last fall by Mr. Toole for Marcus Daly for $60,000, but was later on thrown up. The ore is high grade pyrrhotite and copper pyrites.

A contract for a hundred-foot shaft on the Old Ironsides is to be let in a few days by the Old Ironsides Mining Co. This company was formed in Spokane early last fall. Capital stock, $1,000,000, in shares of $1 each. The stock is now quoted at 15c. and bids fair to rise in the near future.

The Republic Gold Mining Co., capital stock $750,000, in shares of $1 each, has just been formed to work the "Republic," "None Such" and "Last Chance" claims, Smith's camp. Considerable work has already been done on all three properties. Stock is offered at present at 12½c.

It is expected that Greenwood city will soon be supplied with a water system. The Greenwood City Waterworks and Power Co. are building a dam up Trim creek, which will furnish a head of 300 ft. It is the intention of the company also to install an electric lighting plant, with power from Copper creek.

MINING IN NOVA SCOTIA.

Fifteen Mile Stream.—Mining operations have been carried on in this district for a good many years by different companies and with varied success. The New Egerton Co. took the property over a few years ago from the Egerton Co., and subsequently amalgamated with the Stanley Co., who were also at that time operating in this district. The New Egerton Syndicate is mainly composed of New Glasgow people, the firm J. D. and P. A. McGregor being the largest and managing owners. Mr. George McNaughton has had the management of the mine for the last year, and has been gradually getting it into shape. In the past a 15-stamp mill and three machine drills have been running. These have been found totally inadequate to cope with the supply of ore, and the company are now erecting a new 30-stamp mill, with rock-breaker and all modern improvements. They are also putting in a new 12 x 18 in. Rand air compressor, capable of working nine rock drills. It is expected that the new plant will be ready by the end of July and the owners anticipate doubling the yield of gold with 50 per cent. more men.

During the last six months the mine has yielded on an average 350 oz. of gold per month, with a pay-roll of about 40 men.

The company have applied for incorporation, and propose turning the affair into a joint stock company. We hope to give a detailed account of this mine after the new machinery is in running order.

Mr. Adolph Thies paid a visit to the North Brookfield mine last month, and made an examination of the plant and mine. So satisfied is he of the value of the property that he made a substantial offer for a share of it; but the Brookfield Associates know what a good thing they have and have nothing to sell just now. Mr. W. L. Libbey informed us that the company have changed their mind and intend to erect a new 20-stamp mill, instead of remodelling the old one, which would have necessitated shutting down the mine for at least a month, and that means a clear loss of $10,000 at the present rate of production. The new mill will be placed between the fissure lead and the "big lead." The latter, it is expected, will produce only about 3 to 4 pennyweights of free-milling gold, out of an assay value of 2 oz. 10 dwt., but the remaining gold will be subsequently saved by chlorination. While the company are only erecting a 20-stamp mill at present, they are providing buildings and boiler and engine capacity for 40 stamps. The mill will be built by the Truro Foundry Co., who have supplied many of the best mills in this Province. The yield of gold from this mine for the month of May was 565 oz., and during the last six months it has yielded 2,582 oz. of gold, or an average of 430·3 oz. per month.

There is probably no better sign of prosperity in a gold mining country than to see additional stamps being put in by old companies. Recently we recorded the erection of an additional 20 stamps at the Richardson, and now we find the New Egerton and Brookfield both adding to their milling capacity. The result of the additional stamping capacity at the Richardson has been to practically double the yield, while the cost of mining and milling has been reduced from $2.05 to $1.65 per ton, and as there is plenty of ore in sight at both the other properties it may fairly be expected that the additional stamping capacity will have an equally good effect. There is not the shadow of a doubt that there are many other properties in Nova Scotia which will bear increased development and a greater number of stamps, and we are disposed to think that one of the main causes of failure in the past has been lack of proper development and a tendency to put all profits (a percentage of which should fairly go to development) to dividend account. That the gold mining industry of this Province is gradually coming out of the "Slough of Despond" in which it has been for some time all who are intelligently watching the industry will readily admit, and we verily believe that the time is not very far away when capitalists will look upon Nova Scotia gold mines with favor, and the industry will become the staple industry of the Province.

The Richardson mine yielded 250 oz., and the Golden Lode 219 oz. of gold for the month of May.

Mr. C. F. Andrews has taken up a number of coal areas in Guysboro' County. He considers that there are fair indications and proposes prospecting for coal this summer.

Mr. C. E. Willis, representative for the Canadian Rand Drill Co. in Nova Scotia, was married on June 3rd to Miss Emma Bradley Howard, of Richmond, Virginia.

Mr. J. A. Fraser is removing his crusher from Forrest Hill to Goldenville. He finds that the property will not pay a dividend on the price asked for it, and so he is relinquishing the bond.

We have received from Mr. E. R. Faribault the Tangier Sheet, being the first of a new series of maps published by the Geological Survey Department. This series will consist of Tangier, Sheet Harbor, Fifteen-Mile Stream, Trafalgar, Stellarton, New Glasgow, Cape John, Pictou; West River, Pictou; Head of Stewiacke, Upper Musquodoboit, Moose River and Ship Harbor. Mr. Faribault writes us that a report on the gold fields of the eastern part of the Province will be published next year.

The Golden Lode mine produced 219 oz. of gold last month, and paid the usual monthly dividend of 5 per cent. on its capital of $30,000.

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In the case of the Professorship of Mining, and of the Assistant Professorship of Civil Engineering, experience in laboratory work is essential. The Assistant Professor of Civil Engineering should also have a thorough knowledge of Hydraulics.

Candidates for the Assistant Professorship of Descriptive Geometry and Freehand Drawing should have a knowledge of Architectural Drawing, as the Assistant Professor of this subject will be expected to give assistance to the Professor of Architecture.

Candidates for any of the above appointments must send their names to the undersigned, together with a statement of their age, previous career and qualifications, with such testimonials as they may think desirable, not later than the 14th of July.

J. W. BRAKENRIDGE,
Acting Secretary, McGill College.

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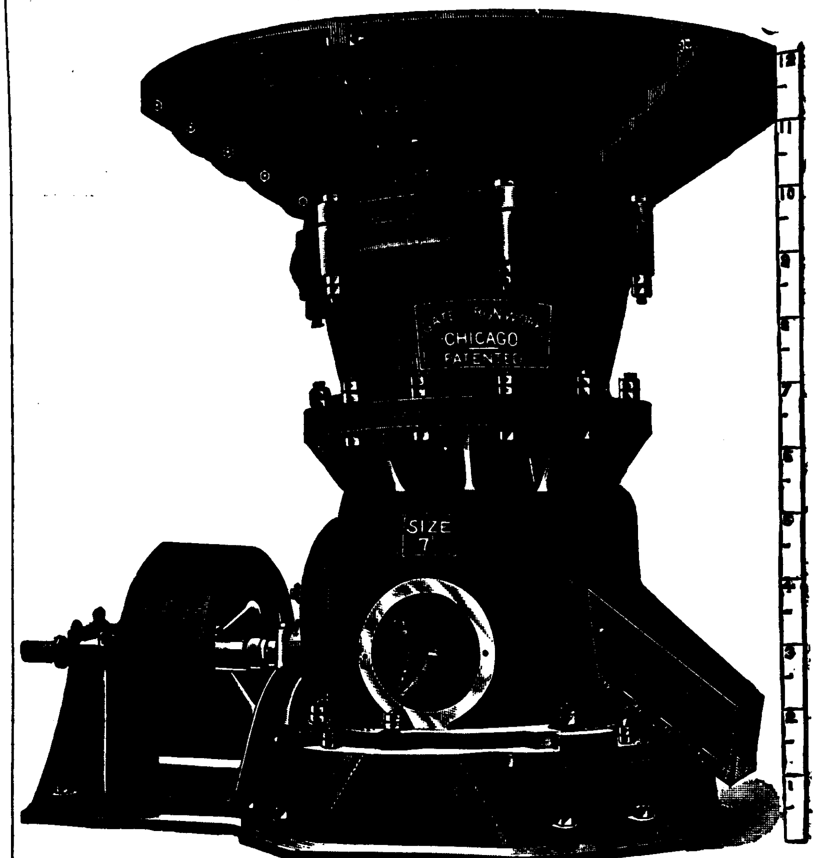

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—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of chap. 1, Acts of 1892, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted gold valued at $18 an ounce.

Applications for Licenses or Leases are receivable at the office of the Commissioner of Public Works and Mines each week day from 10 a.m. to 4 p.m., except Saturday, when the hours are from 10 to 1. Licenses are issued in the order of application according to priority. If a person discovers Gold in any part of the Province, he may stake out the boundaries of the areas he desires to obtain, and this gives him one week and twenty-four hours for every 15 miles from Halifax in which to make application at the Department for his ground.

MINES OTHER THAN GOLD AND SILVER.

Licenses to search for eighteen months are issued, at a cost of thirty dollars, for minerals other than Gold and Silver, out of which areas can be selected for mining under lease. These leases are for four renewable terms of twenty years each. The cost for the first year is fifty dollars, and an annual rental of thirty dollars secures each lease from liability to forfeiture for non-working.

All rentals are refunded if afterwards the areas are worked and pay royalties. All titles, transfers, etc., of minerals are registered by the Mines Department for a nominal fee, and provision is made for lessees and licensees whereby they can acquire promptly either by arrangement with the owner or by arbitration all land required for their mining works.

The Government as a security for the payment of royalties, makes the royalties first lien on the plant and fixtures of the mine.

The unusually generous conditions under which the Government of Nova Scotia grants its minerals have introduced many outside capitalists, who have always stated that the Mining laws of the Province were the best they had had experience of.

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones; five per cent.; Coal, 10 cents on every ton sold.

The Gold district of the Province extends along its entire Atlantic coast, and varies in width from 10 to 40 miles, and embraces an area of over three thousand miles, and is traversed by good roads and accessible at all points by water. Coal is known in the Counties of Cumberland, Colchester, Pictou and Antigonish, and at numerous points in the Island of Cape Breton. The ores of Iron, Copper, etc., are met at numerous points, and are being rapidly secured by miners and investors.

Copies of the Mining Law and any information can be had on application to

THE HON. C. E. CHURCH,

Commissioner Public Works and Mines,

HALIFAX, NOVA SCOTIA.

DRUMMOND, McCALL & COMPANY.

IRON, STEEL & GENERAL METAL MERCHANTS.

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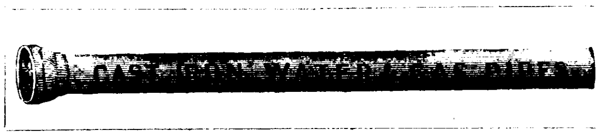

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