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THE Canadian MINING REVIEW

Established 1882

Vol. XIII.—No 6 1894—OTTAWA, JUNE—1894. Vol. XIII.—No. 6.

Ontario's Great Mineral Fields

100,000 SQUARE MILES.

PROSPECTORS, Miners and Capitalists are invited to the great Mineral Field of Ontario, the most promising ground on the continent for exploration and investment.

The Province of Ontario has a mineral-bearing territory 1,000 miles in length, by 100 miles in breadth. Only a small portion of the territory has been explored.

NICKEL, IRON, ANTIMONY, APATITE,
MICA, COPPER, GOLD, GALENA,
ACTINOLITE, TALC, COBALT, SILVER,
ZINC, ASBESTOS, PLUMBAGO, ETC.

Thousands of square miles of virgin ground for the prospector Laurentian and Huronian formations, more easily reached by lake or railway than any other mineral district of the continent.

Important Discoveries made every Season! Careful and Intelligent Exploration Amply Rewarded!!

The Attention of Miners and Capitalists in America and Europe is invited.

Mineral Lands are sold by the Government at $1.50 to $3 per acre, or leased with right of purchase at from 60 cents to $1 per acre first year, and 15 to 25 cents for subsequent years. The first year's rental allowed as part of the purchase money, should freehold be desired.

The NICKEL and COPPER mines at Sudbury prove the ore rich and persistent, shafted to 750 feet in depth, and richest in the lower levels.

Report on Mineral Resources of Ontario, with geological map of the Province (580 p.)

Reports of Bureau of Mines, the Mines Act, 1892, and the Amendment Act of 1894, furnished free on application.

FOR FURTHER INFORMATION ADDRESS:

A. S. HARHY, Commissioner of Crown Lands

OR

ARCH. BLUE, Director Bureau of Mines, Toronto, Ont.

CANADIAN MINING & MECHANICAL REVIEW

CONDUCTED BY - - - - - - B. T. A. BELL.

THE OFFICIAL ORGAN

—OF—

THE GOLD MINER'S ASSOCIATION OF NOVA SCOTIA,
THE UNITED MINING SOCIETY OF NOVA SCOTIA,
THE ASBESTOS CLUB, QUEBEC,
THE GENERL MINING SSOCIATION OF QUEBEC.

OFFICES:

Victoria Chambers, 140 Wellington Street,

OTTAWA.

Vol. XIII. JUNE, 1894. No. 6

The Cape Breton Meeting.

As announced in previous issues the members of the General Mining Association of the Province of Quebec and the Mining Society of Nova Scotia will meet at Sydney, Cape Breton, during the week commencing 10th July next. The programme of the proceedings is as follows:—

TUESDAY, 10TH JULY.

At 10 a.m. the party will leave the Landing Stage, near the New Sydney Hotel, on the Dominion Coal Company's steam tug for the International Pier.

The approaches to the Pier and the grading of tracks are well worthy of attention. The whole of this work has been carried out under the personal superintendence of Mr. Hiram Donkin, C.E.

The party will return to Sydney and lunch at the Hotel at 12 o'clock.

At 1 o'clock a special train will be in attendance at Sydney Station to convey the party to the Dominion Coal Company's Caledonia Mine, which is equipped with patent self-dumping cages, and screening and loading arrangements of the most complete kind. The iron pit-frame and landing stages, upwards of 80 ft. in height, are a special feature.

The large Compound Air and Compound Condensing Steam Rand Compressor, which was exhibited at the World's Fair, has recently been laid down at this pit to work coal cutting and pumping machinery.

A range of Babcock & Wilcox boilers, working at a pressure of 100 lbs., is in operation, and below ground, endless Cable Haulage, Ingersoll Coal Cutting machinery and Stanley Coal Header.

The whole will be inspected under the guidance of D. McKeen, Esq., M.P., General Manager, and Mr. W. Blakemore, Mining Engineer to the Dominion Coal Company.

Return to Sydney from Glace Bay Station at 6 o'clock.

A meeting will be held in the Assembly Room of the Sydney Hotel, promptly at 7.30 p.m., for the transaction of business and reading of papers.

WEDNESDAY, 11TH JULY.

Leave the Landing Stage, Sydney, on the ordinary Ferry Boat at 10 o'clock, arriving at North Sydney at 10.30 a.m., where the party will be met by R.H. Brown, Esq., M.E., and conveyed over the private line of the General Mining Association to the old Sydney Mines, which present many special features of interest. These mines have been in operation longer than any other in Cape Breton, having been established upwards of 100 years. The workings extend some distance under the Atlantic Ocean, and the coal is hauled to pit bottom by main and tail rope.

After inspecting the mines, the party will be entertained at luncheon by R. H. Brown, Esq., and will return to Sydney by the afternoon boat, leaving North Sydney at 3 o'clock. In the evening, D. McKeen, Esq., M.P., will entertain the party at dinner at the Sydney Hotel, where they will meet some of the leading gentlemen of the district.

THURSDAY, 12TH JULY.

The party will leave Sydney Station at 9.45 a.m. for Cow Bay, where the Dominion Coal Company's Gowrie Mine and Pier are situated. After a brief inspection of these, they will, if practicable, and arrangements can be made, proceed on the Company's steam tug to Louisburg, a distance of about 30 miles. This will be a most enjoyable excursion, and will afford an opportunity of inspecting the old French fortifications, and making the acquaintance of a town which possesses great historic interest. The party will return from Louisburg by the same tug at 4 o'clock, arriving at Sydney about 8 p.m.

FRIDAY, 13TH JULY.

The Eastern Development Company, through Mr. Isaac P. Gragg, President and General Manager, has very kindly invited the party to visit the Coxheath Copper Mines, either as a body or as individuals, during the week of this meeting. Further details of this excursion can be learned at the headquarters at the Sydney Hotel during the meetings.

Should the day prove propitious, it has been proposed on Friday afternoon to take a steamer on Little Bras d'Or for an excursion through some of the beautiful bays of the Bras d'Or Lake, terminating at Grand Narrows Friday evening.

A large party of delegates from the Quebec Association will sail from Montreal at daybreak Thursday, 5th July, on the steamer "Bonavista," which has been kindly placed at their disposal at a greatly reduced fare for the round trip by the courtesy of Messrs. Kingman, Brown & Co., Montreal. The Intercolonial Railway will also carry members from Levis to Sydney and return at a single fare, while the Canadian Pacific, Grand Trunk and other railways will issue tickets at a fare and one-thied to delegates travelling from points on their lines to the place of meeting. Those members going by boat are requested to be on board ship at Montreal on Wednesday evening, the 4th July, but members who cannot join the party at Montreal may do so at Quebec, on the evening of 5th July, by communicating with the agents of the Black Diamond Steamship Company in that city. Immediately after the meeting the "Bonavista" will sail from Sydney for Montreal.

The members of the Mining Society of Nova Scotia will leave Halifax at 8 a.m. local time on Monday, 9th July, reaching Sydney same even ing at 9.30 p.m., a drawing room car for their accommodation being provided by the courtesy of the Intercolonial Railway, which will also carry them for a single fare Both societies will rendezvous at the New Sydney Hotel, where special rates for their accommodation have been provided by Col. Brownell Grainger.

Every effort has been made by the local committee, notably Mr. David McKeen, M.P., Mr. R. H. Brown, M.E., and Mr. W. Blakemore, M.E., to ensure the comfort and enjoyment of those members and guests who may be able to avail themselves of this opportunity to visit an Island which possesses many features of interest to those associated with mining, together with rich and varied scenic attractions and historical associations, which cannot fail to render the visit one of great profit and enjoyment to all who may be able to go. Every mining engineer in Ontario, Quebec and Nova Scotia who can spare time for a couple of weeks' holiday should avail themselves of this excellent opportunity to visit and inspect the largest and most important coal field in the Dominion.

Our next issue, profusely illustrated with portraits, photographs of the collieries and other works to be visited, and a complete geological map to date of the Sydney coal field specially prepared for this number, will contain as usual a verbatim report of the proceedings of this exceptionally attractive and important occasion.

The American Society of Mechanical Engineers—Montreal Meeting.

The twenty-ninth meeting of the American Society of Mechanical Engineers was held at Montreal during the week commencing 5th June. About 200 ladies and gentlemen participated in the proceedings.

The first event was a drive around Mount Royal Park. Unfortunately the weather was stormy, but the drive took place nevertheless in closed carriages. The magnificent view from the mountain was of course obscured, but a champagne lunch in connection with the vivacity of Col. Stevenson, did much to enliven the occasion.

The opening session was held Tuesday evening at Molson Hall, McGill University, and was presided over by Mr Herbert Wallis, of the Canadian Pacific Railway, chairman of the local committee of entertainment. Addresses of welcome were made by Mayor Villeneuve, Sir Donald A. Smith, Professor Bovey (of McGill), and Mr. Geo. Hunt (on behalf of the local association of Stationary Engineers. A graceful response was made by the Society's President, Mr. Eckley B. Coxe, followed by his formal presidential address. Mr. Coxe is a man of distinguished attainments, both in a scholastic and practical sense, and of equally distinguished achievement, than whom no one is better able to deliver weighty sentiments on his chosen subject. The address displayed a breadth of view such as might have been expected from such a source

He outlined the great advance that had been made in this branch of education in recent years, and commented upon the well-known fact that in the United States the command of the industrial army is rapidly drifting into the hands of technical school gradnates, in spite of which, however, there is a widespread feeling that the methods and programmes in use are not wholly satisfactory. This he considered inevitable, in view of the fact that the whole subject of technical education was a new one, almost without precedent or guide. A most healthy sign, however, was the fact that those conducting these schools are themselves aware of their shortcomings and alive to determine the reasons and remedies.

He proceeded to classify engineers, placing at the head of his classification the business engineer, by which he meant not simply an engineer who had drifted into business, but one whose range of vision was large enough to include business and financial considerations in forming his judgment, and thus at times decide upon courses of action which from a purely technical point of view might seem wrong. Such men, he said, were very rare, and when once known were sure to command high salaries. He then went on to describe the changes that had come over the engineer's work of late years in the direction of specialization, and enlarged upon the fact that this rendered it more difficult than formerly for the young engineer to acquire an all-around line of experience.

His contention was that the schools should so far as possible supply this all-around knowledge, that is, direct their energies toward the development of men well grounded in those fundamental principles which lie at the base of all specialties, and not attempt the training of specialists. He also animadverted against the practice of making higher mathematics the one great feature of an engineering education. Though an accomplished mathematician himself, Mr. Coxe has sufficient breadth of mind to recognise that many of the most successful engineers have not possessed the mathematical faculty except in a moderate degree, and to make mathematics the one criterion of the course was in his mind clearly a mistake.

Following the presidential address, the Society made an inspection of the equipment of the Engineering Building, and from all sides were heard words of unstinted praise and admiration for Canada's great technical school.

The regular business of the reading of papers was taken up Wednesday morning, when the following list of papers was gone through :

A. K. MANSFIELD : Notes on the Theory of Shaft Governors.

ALBERT F. HALL : Heat Units and the Specifications for Pumping Engines.

W. H. BRISTOL : A New Recording Pressure Gauge for Extremely High Ranges of Pressure.

FRANK RICHARDS : A Note on Compressed Air.

A. W. ROBINSON : The Relation of the Drawing Office to the Shop in Manufacturing.

It should be stated that under the system developed by the Society's mose efficient Secretary, Prof. T. R. Hulton, of Columbia College, the amount of work performed is very great. All manuscript is required to be in the Secretary's hand some weeks before the meeting. The papers are at once put in type and printed copies are sent to all members, who signify (by a blank postal card sent out for that purpose), their intention of attending the meeting. Each member attending is then presumed to have read the papers which interest him before the session opens. Consequently the paper is not read except by brief abstract, and almost the entire time of the sessions is thus available for discussion. The discussions are thus very full and are often of far more value than the papers which call them out.

Of the papers on the above list, that by Mr. Mansfield called out the most animated discussion. Mr. Mansfield's paper was chiefly an exposition of the "inertia effect" and its combination with the usual centrifugal effect. The inertia governor is a comparatively new development, which has been the subject of several previous papers before the Society, and it is a subject which is sure to give rise to a warm discussion. A leading part in the discussion was taken by Prof. Jocobus, of Stevens' Institute, who proceeded to demonstrate that unless handled with great intelligence the inertia governor was one of those things which had best be let alone. He produced some extremely interesting diagrams taken in the course of extended experiments on an engine fitted with an inertia governor, which showed plainly enough that it was very easy to apply an inertia in connection with a centrifugal governor in such a manner that the inertia governor should injure instead of improve the regulation.

The paper by Mr. Bristol also called out an animated discussion, and one which brought out some interesting facts, although the remarks drifted a long way from the subject of the paper. Among the more interesting remarks were those by Mr. Almond, of Brooklyn, N.Y., who gave an account of some unique experience in making spiral springs of steel. The steel wire was required to be extremely hard—so much so that it was found impossible to coil it to the required size without repeated breaking. This was finally overcome by running the wire through boiling water and immediately cooling it, the low heat of boiling water being sufficient to soften the wire so as to permit coiling.

Wednesday afternoon was occupied by an excursion down the Lachine Rapids, by a steamer furnished by the harbor commissioners —the trip to the head of the rapids being by special train tendered by the Grand Trunk Railway. After "shooting" the rapids the steamer took the party down the river past the city, finally putting about and landing the excursionists at Lachine basin.

The evening was occupied by a charming social function—a reception at the residence of Sir Donald A. Smith. A pleasant time was spent in inspecting Sir Donald's superb collection of paintings and curios, the japanise collection receiving, perhaps, the greatest expressions of appreciation.

At Thursday morning's session the following papers were discussed :

R. H. THURSTON : The Theory of the Steam Jacket ; Current Practice.

D. S. JACOBUS : Results of Experiments with a 50 h. p. Single Non-condensing Ball & Wood Engine to determine the Influence of Compression on Water Consumption.

FRANK H. BALL : Cylinder Proportions for Compound Engines, determined by their Free Expansion Losses.

F. M. RITES : A New Method of Compound Steam Distribution.

JESSE M. SMITH : Tests of a Small Electric Railway Plant.

W. S. ALDRICH : Power Losses in the Transmissive Machinery of Central Stations.

The first paper was extensively long, after the manner of Prof. Thurston's papers, and was expected to lead to a battle royal. Prof. Thurston is an ardent and uncompromising advocate of the steam jacket, and other equally able members are well known to be equally pronounced opponents. Those who enjoy a wordy passage at arms were, however, disappointed, as Prof. Thurston had unavoidably been detained from attending the meeting.

The paper by Mr. Ball, (well known as the inventor and builder of the Ball engine) was an explanation of a method of proportioning the cylinders of a compound engine, with reference to minimising the bed losses rather than the equal division of the load as has heretofore been done.

The paper by Mr Rites commands attention as does anything from his hand. Mr. Rites is well known as the inventor of the system of steam distribution employed in the Westinghouse engine—a system which has peculiar and unique advantages when employed non-condensing and under extremely varying loads—as for instance, in electric work, which in fact, first furnished the incentive for its development.

After adjournment the party assembled at the power house of the Montreal Street Railway Company, where luncheon had been proposed. The plant was much admired as an illustration of thoroughly high grade engineering, without the gilt edged and silver plated accessories that now-a-days are too often brought in where they have no proper place. Following this a visit to the Grand Trunk Railway shops had been planned, but had to be omitted as the shops were closed by reason of the coal famine, and in lieu thereof, the members attended a very pleasant garden party, tendered by Mrs. Frank Redpath and Mrs. Bovey at the residence of the latter.

Thursday evening was occupied by a professional session, at which the following papers were taken up :

M. P. WOOD : Rustless Coatings for Iron and Steel.

JAS. MCBRIDE : Corrosion of Steam Drums.

C. W. HUNT : A New Mechanical Fluid.

F. R. HUTTON : First Stationary Steam Engines in America.

DECOURCY MAY : Cost of an Indicated Horse Power.

JNO. R. FREEMAN : A New Form of Canal Waste Weir.

The paper by Mr. Wood went into the various processes for protecting iron and steel from corrosion, and enlarged upon the reasons which had lead to the commercial failure of some which had been technically successful. His conclusion was that the best available protection was first-class paint—linseed oil and pure white or red lead. Mr. Hunt's paper was a description of a new method of adjusting connecting rod ends to take up wear by means of a cavity behind one of the brasses filled with small steel balls. The screw enters this cavity and displaces the balls much as a pump plunger displaces water in a pump barrel. Mr. Hunt stated that the construction was cheap and satisfactory, the adjustment being very delicate and permanent.

At the conclusion of this session Prof. Bovey

entertained the members in the testing laboratory by showing the operation of the various testing machines.

At the Friday morning session the concluding papers were taken up as follows:

G. W. BISSELL: Effect of Varying the Weight of the Regenerator in a Hot-air Engine.

W. R. RONEY: Mechanical Draft for Boilers.

R. C. CARPENTER: The Saturation Curve as a Reference Line for Indicator Diagrams.

DENTON-JACOBUS-RICE: Results of Measurement of the Water Consumption of an Unjacketed 1600 h. p. Compound Harris-Corliss Engine.

F. B. KING: Notes on the Corrosion of a Cast Steel Propeller Blade.

Of the above, the paper of most general interest, was that by Mr. Roney. Mr. Roney is well and favorably known as the inventor of a successful mechanical stoker, which is "handled" commercially in connection with the Westinghouse engine. The paper here presented urged the abandonment of chimneys, except so far as is necessary to get rid of deleterious gases, and the substitution of a fan for producing draft, in connection with a fuel economizer to save the heat still in the gases after passing the boiler. In this way the temperature of the gases can be reduced to a point which would give no adequate draft with a chimney, and the claim is that the heat thus saved gives a much greater amount of power than is necessary to drive the fan, in other words, the fan draft is produced at a smaller expenditure of heat than the chimney draft.

This closed the professional sessions. In the afternoon many of the members visited the works of the Canadian Rubber Company, while others attended a very pleasant garden party at the house of Mr. J. H. R. Molson.

The programme provided for an excursion to Ottawa on Saturday by special train over the Canadian Pacific Railway. A considerable number, however, manifested disappointment that Quebec city had been omitted from excursions, one gentleman remarking that "Canada without Quebec was like Hamlet without Ophelia." In consequence, a party was made up to visit that famous city. The main contingent however selected the Ottawa trip, where the Ottawa Electric Railway Co's power house, the sawmills of J. R. Booth and the Parliament Buildings were inspected. Luncheon provided by Ottawa citizens was served on the grounds of T. C. Keefer, and a garden party at Rideau Hall on the invitation of His Excellency the Governor General completed the entertainment.

On all sides and throughout the convention constant expressions of appreciation at the generous hospitality extended were heard, as well as remarks showing the extremely favorable impressions made by Canada, Montreal, and especially McGill University. This convention was heralded by less blaze of trumpets than some previous meetings, but it is safe to say that none has resulted in furthering to a greater degree that mutual acquaintance of these two sister peoples, which is after all the greatest good accomplished by these international meetings.

EN PASSANT.

We understand that the Dominion Government has under consideration an appropriation of $7,000 to be applied in drilling the enormous area of tar sands discovered by Mr. R. G. McConnel, B.A., in his geological survey of the Athabaska Country, N.W.T. The tar sands have been estimated by Mr. McConnel to have a minimum distribution of fully 1,000 square miles. They vary in thickness where the section is complete from 140 to 225 feet. The following calculations extracted from the Summary Report of the Geological Survey for 1890, although it can only be regarded as an appropriation, will serve to give some idea of the enormous outpouring of bituminous substances which has taken place in this region:—

"An analysis by Mr. Hoffman of a specimen collected some years ago by Dr. Robert Bell, gave by weight:

Bitumen	12.42
Water (mechanically mixed).....	5.85
Siliceous Sands.....	81.73

A cubic foot of the bituminous sandrock weighs, according to Mr. Hoffman, 117.5 lbs. This figure multiplied by the percentage of bitumen, 12.42, gives 14.59 lbs. as the amount of bitumen present in a cubic foot, or $\frac{14.59}{117.5}$ = 22.9 per cent. in bulk. Taking the thickness at 150 feet, and assuming the distribution as given above at 1,000 square miles, the bituminous sands in sight amount to 28.40 cubic miles. Of this mass, if the preceding analysis is taken as an average, although it is probably rather high, 22.9 per cent. in bulk, or 6.50 cubic miles is bitumen. The amount of petroleum which must have issued from the underlying limestones to produce 6.50 cubic miles, or by weight approximately 4,700,000,000 tons of bitumen, cannot now be estimated, as the conditions of oxidation and the original composition of the oil is unknown. It must, however, have been many times greater than the present supply of bitumen."

"The commercial value of the sands themselves as exposed at the surface" says Mr. McConnel, "is at present uncertain." But the abundance of the material and the high percentage of bitumen which it contains, makes it probable that it may, in the future, be profitably utilized for various purposes, when this region is reached by railways. Among the uses to which it is adapted may be mentioned roofing, paving, insulating electric wires, and it might also be mixed with the lignite which occurs in the neighborhood, and pressed into briquettes for fuel.

We understand that an experienced well driller has received the contract, and that work will be proceeded with just as soon as the appropriation is ratified by parliament. The tar sands evidence an upwelling of petroleum to the surface unequalled elsewhere in the world, but the more volatile and valuable constituents of the oil have long since diappeared, and the rocks from which it issued are probably exhausted as the flow has ceased. In the extension of the tar sands under cover the conditions are different, and it is here Mr. McConnel points out that oils of economic value should be sought. In ascending the Athabasca, the tar sands are overlaid at Boiler Rapid by a cover of shales sufficient to prevent the oil from rising to the surface, and in ascending the river, this cover gradually thickens. The geological attitude of the shales is not the most favorable, as the beds dip away from the outcrop at the rate of five or ten feet to the mile, and it is possible that a part, or even the whole of the oil may have flowed northwards and eastwards through the sands, and escaped where these come to the surface. It is unlikely, however, that all the oil has escaped in this manner, as small anticlinals in the covering beds are almost certain to exist, and a differential hardening of the beds themselves may serve to inclose reservoirs or inverted basins of large capacity. It is also possible that the sands at their outcrop, may by the deposition of tarry substances be plugged tightly enough to prevent further egress. Favourable indications of the presence of oil in the vicinity of the Athabasca, are also afforded by the existence of natural gas springs.

The question of the continuity of the tar sands and their petroliferous character under cover, can, however, only be settled in a decided manner by boring. At the mouth of Pelican river where the drilling will be done, the tar sands are probably covered by about 700 feet of strata, and this amount increases as the river is ascended At the Athabasca Landing, if the formation extends to that point, it probably lies at a depth of from 1,200 to 1,500 feet below the surface, but the distance of the landing from the outcrop of the tar sands, and the variability of the thickness of the cretaceous formations make it impossible to give more than a rough estimate.

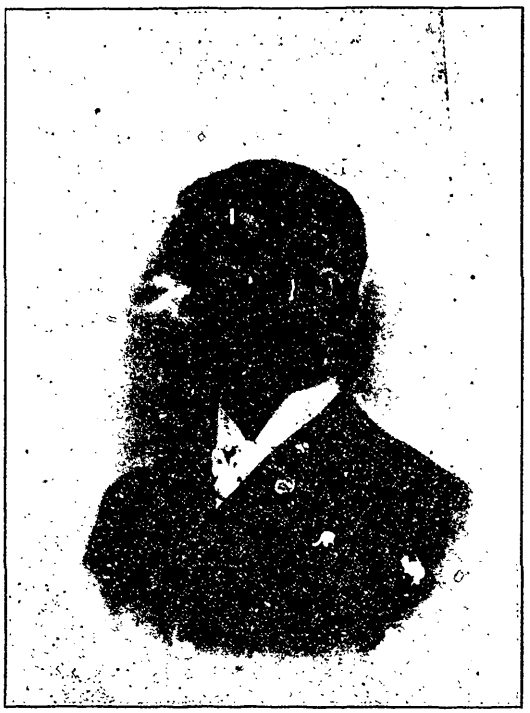
Tenders are asked for 300 feet of tunnelling on the Canadian Pacific Mining and Milling Co's gold property, on Woodberry Creek, near Ainsworth, B.C.

The *Nakusp Ledger* reports that an American syndicate is negotiating for control of the Noble Five group of mines, in the Slocan county, B.C. Price: 300,000.

A recent discovery of coal on Buffalo Point, Lake of the Woods, the extreme south-eastern part of Manitoba, is reported to have been acquired by a Winnipeg Company for $30,000. A prospecting outfit has been sent out.

Mr. J Keith Reid, C.E, Montreal, who has spent the past two seasons in the Kootenay County, B.C., has returned to Montreal. He has completed a very handsome wall map showing the mines and mining camps, roads, trails, railway and water routes, and other features of much interest to mining men interested in the Kootenay County. The original of Mr. Reid's map, will in all likelihood, be acquired by the British Columbia government, or the Canadian Pacific Railway, and the reproductions on the smaller scale should find a ready sale From personal examination we can confidently recommend this excellent piece of work to our readers.

MR. F. A. HALSEY, Sherbrooke, Que.,
Manager of the Canadian Rand Drill Co.



MR. E. W. GILMAN, Montreal,

Managing Director and Secretary, The Ingersoll Rock Drill Co, of Canada.

Messrs. Henry Barber & Co., Toronto, have been appointed liquidators in the estate of the Drury Nickel Company, Ltd., of Sudbury, now being wound up. Liabilities, $61,000. The assets are estimated at $100,000, and consist of the mining property, machinery plant, buildings, and nickel ore on hand.

"It is certain that when the much and long wished for revival comes, no industry will feel its beneficial results more quickly or more deeply than will that of the manufacture of all kinds of electrical machinery and appliances. The great activity in this industry, that had only gotten fairly under way when the reaction set in a year ago, was a very genuine one, and when the times are again better it is morally certain that the business in this line will be greater than ever before. The demand for the projected electric roads, for the new lighting plants, for the new motors and dynamos, is a growing one, and if for a time suppressed, is sure to rise again like a hidden stream, with greater force than before."—*Boston Manufacturers' Gazette.*

And when it does come look out for a boom in Canadian mica.

The coal shipment from British Columbia for the month ending 31st ulto, were:

	tons.
New Vancouver Coal Mining and Land Co.	29,110
Wellington Colliery	23,269
Union Colliery	17,046

Our portrait series would be incomplete indeed did it not include a representation of those important manufacturing industries which have sprung into activity with the steady growth of mining affairs in Canada. The foremost of these, as all our readers know, are the Ingersoll Rock Drill Company of Canada, and the Canadian Rand Drill Company, operated respectively under the energetic and enterprising management of two very good fellows—Mr. E. W. Gilman, Montreal, and Mr. F. A. Halsey of Sherbrooke, Que., both of whose photographs are reproduced in this month's REVIEW. Mr. Gilman who is the son of the Hon. F. E. Gilman, a member of the Legislative Council of Quebec, is a native of Montreal, having been born there in 1867. He was educated in the Polytechnic School at Worcester, Mass., where he graduated as a Mechanical Engineer in 1888. After some time spent in visiting different shops and mines in the United States, he accepted a position with the Ingersoll Rock Drill Co., being elected secretary and managing director to the company in 1893. Mr. Gilman is a member of the General Mining Association of Quebec and other organizations. The large establishment over which he presides has its headquarters at St. Henry Station, a suburb of Montreal, and is running full time, employing a large number of skilled mechanics on those special lines of rock drills, air compressors, coal cutting machinery, and other mining appliances for which the Ingersoll Company enjoys a world-wide reputation.

Mr. F. A. Halsey, like Mr. Gilman, is too familiar a figure in the mining districts of the country to require any introduction from us, but a few lines respecting his career will not be without interest. Born at Madilla, N.Y., in 1850, he pursued a full course of mechanical engineering at Sibly College, Cornell University, from which he graduated in 1878. After a year's practice as a working machinist in local shops, he made his first business connection with the Brush Electric Co. of Cleveland, Ohio, in 1879. This was at the very beginning of commercial electric lighting and but for untoward circumstances he would undoubtedly have been a specialist in electricity. At the Brush Works he had charge of the testing room which, however, unfortunately resulted in such a violent attack of inflamation of the eyes that Mr. Halsey was compelled to abandon the work. In 1880 he entered the service of the Rand Drill Co. of New York. In 1890, on the occasion of the organization of the Canadian Rand Drill Co. he was appointed its manager, with headquarters at Sherbrooke, Que.; still, however, retaining his connection with the parent company in a consulting capacity. In connection with his present position, Mr. Halsey has had a very congenial work—one that all mechanics covet but seldom get—the organization of a new machine shop "out of the whole cloth," with the result that there has been established at Sherbrooke, Que. a "factory" shop probably unsurpassed in Canada, in the ingenuity and completeness of its equipment,—by a "factory shop" we mean a manufactory for certain specialties only, as distinguished from the general or jobbing shop. Special tools, jigs, fixtures, and gauges are provided for almost every operation, incidental to the work and as a consequence the Canadian Rand Drill Company enjoys a high reputation for the excellence and thoroughness of the work it accomplishes for the mining men of the Dominion. In 1893, the Canadian Rand Drill Company acquired the Canadian rights, and entered upon the manufacture of the Harrison Coal Mining machine.

Mr. Halsey is a member of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the General Mining Association of the Province of Quebec, of which he is a member of Council. Among other contributions to the literature of mechanics may be mentioned his papers on "A New Rock Drill," being a description of the "Slugger" of which he is the inventor, and "The Premium Plan of paying for labor," a novel and original method of enlisting workmen in the effort to increased output—a system, by the way, which has been found to work admirably in his shops at Sherbrooke. These papers have been published in the Transactions of the American Society of Mechanical Engineers. Before the General Mining Association of Quebec he has also contributed a valuable paper on "Modern Practice in Economical Air Compressors." In addition to this he is the author of a distinctly valuable work on "Slide Valve Gear," a treatise on steam engine valve motions which has been adopted as a test book in several engineering colleges, including his *Alma Mater.*

Gold Mining in Nova Scotia.

[By a Correspondent.]

South Uniacke District.

The Golden Lode.—This property under the management of Mr. Hayward, one of the owners, is being opened up rapidly. It adjoins the famous Thompson-Quirk mine, and the shaft at a depth of 300 feet, should strike the rich pay streak known to exist there, and which has been worked by the Thompson-Quirk people to the dividing line. The shaft is now down 170 feet, and when completed the mine will be equipped with mill and suitable plant.

Malaga District.

Fisk Areas.—The development work on the Fisk Block here, owned by J. H. Austen *et al*, has already exposed four "leads," all of them showing gold. One lead in particular from 8 to 10 inches wide (where cut) shows very rich quartz. Within ten feet of this rich vein another lead of 4 feet has been struck showing fine gold well distributed. So good is the showing that the parties having the option on the mine, now hold the property at double the amount for which it has been bonded to them.

Minneapolis Mine.—This mine is now being prospected with very favorable results. As it is already well equipped with mining machinery, it will within a few weeks be on the list of producing mines.

Parker-Douglas Mine.—The lawsuit as to the ownership of this mine will soon be determined, and in the event of the plaintiffs substantiating their claim to the mine (everything up to date has been in their favor) active operations will be commenced immediately.

Caribou District.

Touquoy Mine.—This mine is pursuing the even tenor of its way and the usual quota of gold is finding its way to the already well filled pockets of the owner. It is reported that the mine is being examined by some English investors, with a view to purchase. There are on the property large quantities of low grade ore which have never yet been worked.

Lake Lode Mine.—Mr. W. A. Sanders is still working on this property with fairly good results, and he contemplates in the near future thoroughly equipping it with an up to date plant.

The Truro Mine.—This property under the able management of Geo. W. Stuart, is still being sunk upon to strike the rich pay chute, known to exist there, and we hope to report soon another rich strike on this mine, which has a high record.

Guysboro County.

Cochran Hill Gold Mining Co., Melrose.—The extensive new plant on this property is rapidly nearing completion. A 20 stamp Homestake mill of latest design is being erected by the Truro Machine Co. A large and com-

modious boarding house for the miners, and the mine itself is being equipped with a fine air compressor, drills, and Lidgerwood hoisting engine, built by the Ingersoll Rock Drill Co., Montreal. Manager McQuarrie reports that a large body of fair grade quartz has been opened and there is upwards of 800 tons on the dump ready to mill. The mill will be in operation about the middle of July.

Crows' Nest, Melrose.—Mr. Whitner a mining expert, representing the owners of this mine, spent some weeks in and around this district, and he says that considering the amount of development done on the property he is very pleased with the showing. A small mill is on the property, but a new and adequate plant will be installed, on the mine proving equal to anticipations.

Renfrew District.

Dr. C. D. Jenkins of Boston, the patentee of the Jenkins Mill and Amalgamator, has purchased and is now working on the tailings of the "North" mill. His mill is somewhat of a new application to an old principle, similar to that of the Gates Crusher, but which crushes very fine. At present we are unable to say with what result the tailings are being worked, as the clean up is to be monthly and it has not been in operation that long. Dr. Jenkins recently bonded the areas owned by Musgrave *et al* at Mooseland.

Asbestos Mining in Quebec.

Respecting the state of the asbestos market a prominent shipper writes: "I am glad to be able to report some improvement in the condition of trade. We have recently booked several orders in addition to our regular contracts; and I understand others in the trade have also had a good many enquiries and have had some sale. Manufacturers stocks, so far as I can learn, are fairly well depleted, but in the depressed state of trade generally, there is no disposition to contract ahead for any large supplies, and orders are consequently small, all the way from a carload to 25 and 50 tons, the latter figure being the maximum quantity we have sold to any one concern, outside of contracts."

Thetford District.

The Bell's Asbestos Co., Limited, who have been working extensively during the past winter have increased their force, and are operating very extensively this season. An entirely new system of cleaning lower the grades has been introduced, and a large output for the year is anticipated.

Messrs. King Bros. have reopened there mine but are operating only a small force. Their crushing mill is at present closed pending the introduction of new plant for cobbing and cleaning certain portions of their product.

The Beaver Asbestos Co., Limited, has reopened their pits, and employ a large force and increased plant over last year.

The Johnson's Co., have not yet reopened their mine, though some stripping work is being done. The crushing and cleaning plant which has worked continuously throughout the winter is still in operation. A great portion of the old dumps is being put through the mill and a large output of the lower grades is produced.

The Ward Bros. mine has not been reopened this season.

Black Lake.

The Reedsdale mines are still shut down and are likely to remain so this season.

The Anglo Canadian Asbestos Co., Limited, has 80 men on its pay roll and work will be continued vigorously during the season.

The American Asbestos Co. has a large force at work in the upper pits. A steam plant has been installed further back on the hill and mining operations are carried on entirely by steam, the compressor plant being idle. A large output will be made here.

The Glasgow and Montreal Company's pits remain closed pending improved market.

The United Asbestos Co. is in full operation. Since last season a large storage shed has been erected, and a very complete crushing and cleaning plant installed. A tramway system has been constructed to remove all debris to the back end of their property. This line is operated by a Bacon double cylinder double drum link motion winding engine and gives every efficiency.

Ottawa County.

The International Asbestos Co., Limited, of Newark, has a small force at work opening up their mine.

LEGAL INTELLIGENCE.

Attempted Gold Brick Swindle.

On Tuesday 12th instant, Martin C. Hoyt, who claimed to hail from New York, was charged at the Hamilton Police Court with being implicated with others in a conspiracy to defraud Mr. J. H. Smith of Grimsby, out of several thousand dollars, which he was asked to advance on certain gold bricks alleged to be bogus. It appears that a person named Bradley, who claimed to be a an Arizona gold miner, called on Mr. Smith, who by the way, is a retired western miner reported to have made his pile, and after introducing himself was invited to spend the night. During the evening Bradley in a burst of confidence exhibited a copy of the Arizona Flag (a bogus newspaper) containing his portrait and an elaborate description of the big strike he and a Mexican named Gero had made, at the same time producing samples of the quartz. Finally he tells Smith that he has several gold bricks hidden in the neighbouring woods upon which he would like an advance of $8,000 or $10,000. The upshot was that next day a visit was paid to the woods. The gold was there—bricks of it. Would Mr. Smith come up to the city and have it assayed? Certainly. They start to drive to the city; pass a man on the road near the race track. Carriage stops. Does he happen to know a good assayist in the city? Well, he should smile; has the card of one in his pocket now darndest finest assayist outside of Washington; name, Rolston, temporarily stopping at the Royal hotel. Carriage drives on with polite thanks to the opportune stranger.

They arrive at the Royal. W. Rolston is in his room; most polite and affable of assayists. Assay most satisfactory, gold worth $20 an oz., as shown by neatly printed assay form. Mr. Smith notes that this opportunely met assayist has furnace, bellows, all apparatus in his room, and is quite prepared to assay at a moment's notice, though professedly a transient guest. Most opportune and affable of assayists! Perhaps it is at this point Mr. Smith's able-bodied suspicion begins to assert itself, or perhaps it had existed from the first, for Mr. Smith got experience as well as gold in California, and is not easily deceived.

The bricks of gold at the camp Bradley were valued at $25,000, and as the plot developed he wanted to take it down to Mr. Smith's house, and entrust it to his care while he and the Mexican went back for $20,000 more that they wanted to get out of a country plunged in civil war and anarchy, into the Lord's own country, where a policeman's uplifted finger embodies more power than a battalion of militia with Gatling guns in the mob-ridden states of Colorado and Arizona. Smith suggests that it be stored in a bank; but that does not suit Mr. Bradley. He also wants an advance of $8,000 or $10,000 on the gold; part of which the Mexican wants to send to his mother, and the rest is to be used in the expedition back for the rest of the gold. Will Mr. Smith bring that much money to the camp, and then they will take the gold to his house? The ignorant Mexican must see the money for his mother before he will let it out of his sight. Cautious Mr. Smith doesn't see the point of going to a lonely camp in the woods with so much money on him, even to meet a shock-headed Mexican and his now quite confidential friend, Mr. Bradley. Bring the gold to his house and he will draw the money out of the Grimsby bank, and hand it over. Wednesday night Bradley stayed at Smith's again, and it was arranged they should go for the gold in the morning.

The upshot of the matter was that the police were communicated with, but before any arrests could be made the principals had flown. The man Hoyt, who was arrested, was let off, there being insufficient evidence to prove his identity with the gang.

The following judgments involving the interests of miners in the West Kootenay silver county, have been given by Judge Spinks, at Nelson, B.C. :—

Ennis vs. Startsman—Dolly Varden and Archie Mineral Claim.

This was a case heard at the September court of last year, and judgment was reserved until this court. The point on which judgment was reserved was whether a purchaser of an interest in a mineral claim who had not at the time of his purchase and delivery of the bill of sale a free miner's license, but who subsequently on the same day obtained a license, could hold his purchased interest in the claim without forfeiture or otherwise. Judge Spinks held that a free miner's license taken out at any hour of the day reverts back to the inception of the day on which it was issued and therefore the plaintiff's bill of sale of an undivided one-quarter interest in each of the above claims was valid, and he was by the decree of the court held to be legal owner of the same. The judge held further that a free miner's license was not necessary to a purchaser or a devisee under a will, or to the heir in case of intestacy of the owner of a mineral claim or an interest in one until he asserted some right in connection with it.

Cummings et al v. Northern Belle Mining Co.

This was an action brought by a number of miners against the company for unpaid wages aggregating about $2,500. Objection was made on behalf of the company to the service of the summons on the ground that it was made on the superintendent in the company's office at the mine, and not on the registered agent of the company at Kaslo, under the Companies Act. The judge held the service good. The case proceeded to trial, but owing to the fact that all the plaintiffs, except Cummings, were not in court to prove their claims, their counsel was obliged to adjourn their cases until next court. Cummings, however, got judgment for his claim, some $240.

Dawson v. R. C. Adams.

This was a rather complicated case, involving the well known claims Bon Ton and Big Bertha and License. The Bon Ton owners, the defendants, have applied for a certificate of work, so as to obtain a crown grant. The plaintiff, who is the owner of the License claim, seeks to intercept the granting of this certificate, and fyled his affidavit of adverse claim as required by the Mineral Act. This action was intended to be brought to determine the adverse claim. Serious objections were raised by defendant's counsel to the form of the action, and after a lengthened argument the court held the action was not one on the adverse claim, but was one on ejectment. Then the defendant's counsel objected that the summons issued was not one of ejectment at all. After further argument the court dismissed the action with costs. The plaintiffs immediately brought a second action, and on the following day the defendants obtained an order for a stay of proceedings until the costs of the former action are paid.

Mr. Robert Stevenson *President* and Mr. W. L. Hogg *Secretary* of the Stevenson Gold and Platinum Hydraulic Mining Company, Ltd., gave us a call the other day. This company has been incorporated under the statutes of British Columbia, with an authorised capital of $1,000,000, in shares of $100, to develop a placer mining claim, situated between the town and first fork of Granite Creek, Similkameen division of the Yale district, British Columbia, containing in all about 640 acres. Tests on the upper benches, which average from 30 to 150 feet in depth, have given returns as high as $1.50 per cubic yard, but the average is expected to run from 25 to 35 cents to the cubic yard. Both gentlemen appeared satisfied with their efforts to obtain eastern capital to develop their property. Some 3,500 shares being for disposal at $10, for the purpose of obtaining the requisite sluicing machinery and running expenses.

The Halifax Mining Syndicate, Ltd., has been registered, in London, Eng., with a capital of £1,200, in shares of £100.

In our notes in last issue respecting the Renfrew mining district, N.S., we credited the McLeod lode to the Colonial property. The strike made was on the New Haven property, and the extension of the McLeod lode on the Colonial area has not yet been traced. All these properties, however, are now consolidated by the Pictou Development and Mining Co., Ltd., who are working the "Foundation," "McLeod" and "Clement" lodes, the latter being a large vein from 20 to 30 inches, and milling from $5 to $7 per ton.

Late advices from the Pend d'Oreille Country, B.C., gives an interesting report of a recent clean up by the Kootenay Hydraulic Mining Company. 2,200 yards of gravel were sluiced giving a yield of $525 in gold equal to nearly 24 cents per cubic yard. Some of the nuggets being of good size, the largest being worth $5.85. When it is remembered that 8 cents per yard is regarded as profitable working, and that many of the great placers have been worked remuneratively at 3 or 4 cents per yard, this result must be regarded as most encouraging.

Notwithstanding the very high expenditure already incurred by this company in collecting the waters of six or seven mountain torrents by means of a ten mile ditch, it cannot but be recognised that this source of supply is entirely inadequate for the purpose, as it is merely the rush of the spring freshets, and attention is necessarily turned to the magnificent body of water in the Pend d'Oreille river, to ascertain whether it can be made available to supply the water to the monitors with a pressure equivalent to a head of 200 or 300 feet.

Messrs. S. B. Robbins and E. F. Schoemaker who have been mining in Alaska during the past seven years, gave some interesting information respecting gold mining in the far north.

"Last year was a very hard one," said Mr. Robbins, "particularly on those who went up there with barely enough to live on. Over 400 men crossed over into the Yukon basin, some equipped only with a single blanket and enough food to last them a few days. The wages are a half ounce—about $8—a day, but there were two men for every job in sight.

"Every man who goes into the Yukon country should have at least $350 or $400. That is enough to carry him through for a year. He can then winter in the basin and be at once prepared to commence work when the spring opens. Four of my friends during the past season cleaned up $90,000, but their luck was exceptional.

"The great Treadwell mine," said Mr. Robbins, "runs every day in the year except two, Fourth of July and Christmas. There was some talk last year of putting in one hundred additional stamps in order to keep up with the ore output. There are many mines along the coast that are equally as rich as the Treadwell, but the coast line is so rough and the vegetation so rank that prospecting is very slow work.

"There are hundreds of men up there who have claims staked out, on which they are barely able to keep up their assessment work. They have made the same mistake which others have—gone up there as they would to a mine where the base of supplies is distant the journey of a day or two. The past season was very severe. The snow was frequently six feet deep where it usually averages about a foot.

There is room for 100,000 men in Alaska, but they must go there prepared to spend at least four months of the year in idleness. If they strike the country at the right time they can earn good wages at steady employment. I would caution all intending to go there to think well of what they may be called upon to endure."

A valuable discovery of a large deposit of chomic iron is reported from the property at Black Lake, Que., operated by Dr. James Reed, Reedsdale. A force of men are at work opening it up, and about 200 tons have been mined to date. Shipments to the United States have realized $25 to the ton.

A syndicate of American capitalists has leased four thousand acres of land from the Canada Company, three miles north of Thedford, Ont., and test wells for petroleum are being put down. A Petrolea firm has taken the contract to sink holes in different parts of the territory, and a drilling rig of the latest design has arrived on the ground and commenced operations.

Just as we go to press we learn that the Hon. George Irvine, Q.C., is dangerously ill, and that his trusty henchman, Mr. Lawrence J. Lynch, has been severely injured by an accident.

FREE MINING AND SMELTING MACHINERY.

The Subject Discussed in the Tariff Debate in the House of Commons.

Mining and smelting machinery imported prior to the sixteenth day of May 1896, which is at the time of its importation of a class or kind not manufactured in Canada. Free.

MR. J. A. MARA (Victoria, B.C.) When the Government in 1890 decided that mining machinery not made in Canada should be placed on the free list, the Minister of Finance stated that the object was to encourage the mining industry by offering the freest market for procuring the most modern machinery, and he also stated that the most liberal construction would be placed upon the wording of the Act. So far as British Columbia is concerned, I am sorry to say that the benefits that were expected have not been realized. We feel that a liberal construction has not been placed on that Act in many cases; instead of a free and liberal construction, we feel that a harsh and restricted interpretation has been placed upon the Act, that it has not stimulated the development of our mines and only to a limited extent have we been afforded a free market for the purchase of modern mining machinery. From a return laid before the House a few days ago, I find that during the three years, 1891, 1892, 1893, the total value of mining machinery admitted into Canada free of duty was $227,488, of which $79,847 was received by Ontario, $55,999 by Quebec, $53,081 by Nova Scotia, $46,043 by New Brunswick, $20,425 by Manitoba, and only $16,199 by British Columbia. I believe a considerable portion of the machinery credited to Manitoba was entered for British Columbia, but even taking the whole it only amounts to $36,000, or an average of $12,000 a year. I am not in a position to state how many applications were made during those years, but from the many communications I have received I am satisfied that the machinery admitted free of duty was small compared with the applications made. I believe at the time it was the intention of the Government to place a liberal construction on that Act, but difficulties arose in interpreting it, and unfortunately I think the Government applied to the manufacturers to provide them with a list of mining machinery made in Canada. In that list they enumerated almost every article of mining machinery under the sun. For instance, take concentrating machinery for iron and other metals. I am informed that in the Dominion there is no foundry or manufactory that can or has made complete concentrating machinery for the treatment of gold, silver and copper ore. It is true they have manufactured such machinery that will treat iron ore, but none that will treat the precious metals; but this list, which was placed in the hands of the collectors, and is an instruction to them and is for their guidance, covers concentrating machinery for the precious as well as the base metals. That the view I now present is not an exaggerated one will be apparent to the committee from the proceedings of the Quebec Mining Association. I find that in the eastern provinces mining men have had the same difficulties to contend with that we have experienced, but they are fortunate in the fact that they are nearer to the capital. They can get the ear of the Controller of Customs, their grievances can be more easily made known to him than ours at a distance of 2,500 or 3,000 miles, and their difficulties are more easily adjusted. At this late hour I feel it almost necessary to apologise for reading extracts or quotations, but I will make them as brief as possible, and I only do it to make the point I wish to emphasize, that this grievance is felt all over the country, and in British Columbia there is at the present time no more important question than that of having mining machinery admitted free. At the adjourned meeting of the annual general meeting of the Mining Association of the Province of Quebec, Mr. B. T. A. Bell, the Secretary, stated:

One of the resolutions left over from the annual meeting yesterday was that relating to the Customs tariff on mining machinery. As you know, the Dominion Government, with the object of encouraging the mining industry, amended the tariff in 1890 so as to admit the machinery for mining purposes of such class or kind as is not manufactured in the Dominion free of duty. The period was three years, and it expires next month. The Government has renewed the provision until May, 1896. The Act is in the main liberal, but difficulty seems to have been experienced in its interpretation by the collectors at some of the ports of entry. While in several districts no difficulty has been experienced in passing mining machinery free of duty, at others the duty has been imposed on machinery which distinctly was not made in Canada. The collectors seemingly were not instructed what class and kind of machinery should come in duty free. It has been thought that some representations might be made to the Government on the subject.

CAPT. R. C. ADAMS—This is one of the questions I desired to speak about. As it is the law is a perfect farce. I inquired when in British Columbia how it worked there and found that it created a great deal of bother. An importer brought in some piece of machinery which the collector often held for duty pending investigation, and then as likely as not some country blacksmith was found to claim that he could manufacture the machinery.

MR J. BURLEY SMITH—The mining industry is quite as important, if not more so, than any of our other industries, and it seems to me an unwise policy to hamper its development by any tariff restrictions. At present we are only partially relieved of the duty. I refer to the stipulation in this Act whereby only machinery that is not manufactured in Canada shall be admitted duty free. It opens a question as to what machinery is free. For instance, while rock drills as a class are manufactured in Canada, only two particular kinds are made—the Rand and Ingersoll. Yet in Europe, at the present moment, there are actually 34 distinct types of rock drilling machines, some of which contain improvements which were not even dreamt of at the time the Rand and Ingersoll-Sergeant were patented. Now does the law permit me to import any of those other kinds of drills duty free?

MR. B. T. A. BELL—Certainly; I do not think there can be any doubt about it. The Government provides you with a form of declaration in which you simply swear that the machine you are importing is of a class or kind not manufactured in this country, and the collector is bound to pass it. The law is good enough of itself; it is its operation at some of the ports of entry that is defective.

MR. W. H. IRWIN—Mr. Bell's conclusion is that the Act is liberal. The experience of my company has been different. The meaning of the Act is vague and ambiguous—it is so loosely worded that almost anything we use in asbestos mining can be construed by the collectors to be either directly or indirectly manufactured in Canada. Can Mr. Bell tell me just what machinery can be brought in free under this Act.

MR. B. T. A. BELL—That would be a big contract. The whole essence of the Act lies in the words "class or kind." For instance, rock breakers as a class are made in Canada, but the types known as the "Forster," "Wiswell," "Cyclone," and numerous other kinds of crushers are not manufactured. We are entitled beyond a peradventure to bring in these free. The same applies to pumps, and all the various kinds of specialties not manufactured here. The Department evidently is not posted on the details of the subject.

MR. JOHN E. HARDMAN (Halifax), said he had had considerable experience in the operations of the Act, particularly with reference to the importation of machinery for gold mining. At first they had found some difficulty in getting the collectors to arrive at a proper interpretation of the meaning of the Act. As an example, copper plates were admitted free of duty, but when silvered for amalgamating purposes, the Government in order to protect the few silver plating works—which had has a matter of fact no bath large enough to take in these plates—charged the duty. Representations were made by the Gold Miners' Association, with the result that a clear understanding now existed in Halifax, and there was comparatively little difficulty now in getting free entry for machinery. In every case, where the form of declaration had been filled in, the importer never failed to get his machinery in free of duty.

MR. W. H. IRWIN—Unfortunately our experience at the port of Sherbrooke has been very different.

MR. HARDMAN—In Nova Scotia we have no fault to find with the Act.

Then a committee was appointed to wait on the Controller of Customs, and at that interview, Mr. Franchot, who introduced the deputation, addressing the Controller, made the following statement:—

We have come to see you, sir, as representatives of the General Mining Association of the Province of Quebec, regarding the present law relating to the importation of mining machinery. As you are aware the Act admits free of duty all mining machinery of a class or kind not manufactured in the Dominion. The law in itself, as at present is perfectly satisfactory, but its interpretation by some of the collectors has not been satisfactory.

There are several other extracts that I had intended to read, all of which are in the same direction, but at this late hour I am rather afraid that I might tire the patience of the House. It occurred to me that there are three plans by which we might get over the difficulty. One is: To ask that all mining machinery be admitted free, but in interviews which the British Columbia members had with the Minister of Finance, we were clearly told that the Government could not permit that, and I am free to admit that there are many objections to it. One is: That it would be almost impossible to define what is mining machinery. A hammer or a saw would be entitled to free entry just as much as a boiler, or a pick or shovel as a steam engine. I can also see where it would be difficult to arrange this, because the local merchant or trader would have to pay the duties on everything he kept in stock, while the mining man, by making a declaration, would be able to get the same articles in free of duty, and that would not work. Another course that suggested itself to my mind was that mining machinery that is not manufactured within the province where it is to be used should be admitted free; but that is ob-

jected to also, on account of sectionalism. Then a third plan suggested itself, and that is, to append a list of articles of mining machinery that will be useful in the development of gold or silver and copper mines. I have made out a list of this machinery which I intend to submit to the committee and to ask them whether it would not be advisable to amend the item as it stands at present by adding these articles. I have placed on this list, "The Bridgeman Ore Sampling Machine," a machine that is not made in Canada, but is suitable for prospecting and developing mines not already open. Also, "All concentrating, refining, and amalgamating machinery and appliances for the treatment of gold, silver and copper ores." I may state that none of these are manufactured in Canada, and I suggest that they should be made free.

HON. N. CLARKE WALLACE - Are there none of the ore sampling machines made in Canada?

MR. MARA—From the best information I can obtain, I believe that no machines for sampling galena or gold quartz ore are made in Canada? Then there is the "Tremaine Stamp Mill," a small and cheap machine which is very useful; also "Forster's Ore Breakers," which are peculiarly adapted to gold mining, and which have introduced many economies in the treatment of ores. That is not made here. Then there are "water jacket furnaces for galena and silver ores," none of which are made here. I believe there is a furnace for copper ore manufactured in Sherbrooke, but none for galena or gold ores. Then, again, "Root's Patent Spiral Rivetted Water Pipe, and all special lines of piping, manufactured for hydraulicing, and steel plates and rivets used in the manufacture of hydraulic pipes." My object in putting steel plates and rivets used in the manufacture of hydraulic pipes on the list is: That it would be unfair to admit all piping free of duty and not admit the raw material. In British Columbia considerable hydraulic piping has been manufactured, and the manufacturers, I am informed, are not afraid of competition if they can get the raw material, the plates and rivets admitted free of duty. I have also put on this list, "hydraulic motors, Bleichert, Hallidies, and Lidgerwood wire rope, tramways and cableways, and diamond prospecting drills." Now, it is unnecessary for me at present to go over the arguments that have been advanced from time to time in this House in favor of admitting mining machinery free. The justice of that was conceded three or four years ago when the Government placed mining machinery of a class or kind not manufactured in the Dominion of Canada, on the free list. But I will state this: that at no time in the history of British Columbia will the enlargement of the free mining list be of as great service to our province as to-day. In the Kootenay country, in the Toad Mountain, Slocan and Ainsworth districts, the mines are past the prospecting stage; many of them are developed, and I am happy to say are shipping ores. During the last winter over 3,000 tons of ore were hauled on the snow and shipped to American smelters at a cost of from $25 to $40 a ton. This year, when railways will tap that section of country, I believe that shipments will increase tenfold. To illustrate the value of some of these mines, I will give the returns from a few of the companies. The Mountain Chief Company shipped over 300 tons, averaging 130 ozs. in silver, and 70 per cent. lead; the Blue Bird Company shipped 300 tons, averaging 134 ozs. in silver and 71 per cent. lead; the Noble Five Company shipped 350 tons, averaging 150 ozs. in silver and 69 per cent. lead; the Dardanelles Company shipped 150 tons, ranging from 284 to 322 ozs. in silver and from 26 to 30 per cent. lead. Of course, these mines shipped only what is called shipping ore, in many cases handpicked; but for one ton of shipping ore now in sight in these claims, there are 100 tons of concentrating ore. In one claim, the Slocan Star Mine, there have already been proved to be over 12,000 tons of concentrating ore. When we have such valuable deposits of concentrating ore in the Slocan district, I think it is the duty of the Government to assist in every possible way the development of these mines by admitting mining machinery free. When we find that $227,488 worth of mining machinery was admitted free of duty in the last three years, we can see that the manufacturers on the one hand have not been injured, nor on the other hand has the revenue suffered to any great extent. We may reasonably assume that of this amount a large proportion would not have been imported if mining machinery had not been on the free list. I submit to the committee this proposition, for which I ask a favourable consideration, namely, to add the following articles, without restriction or limitation, to the free list:—

The Bridgeman ore sampling machine.

All concentrating, refining and amalgamating machinery and appliances for the treatment of gold, silver and copper ores.

Huntingdon's centrifugal roller quartz mill for gold and silver ores.

The Tremaine stamp mill.

Foster's ore breakers.

Water Jacket furnaces for galena and silver ores.

Root's patent spiral rivetted water pipe, and all special lines of piping manufactured for hydraulicing. And steel plates and rivets used in the manufacture of hydraulic pipes.

Hydraulic monitors.

Bleichert, Hallidies and Lidgerwood wire rope, tramways and cableways.

Diamond prospecting drills.

HON. MR. IVES—Do you claim that wire rope is not made in Canada?

MR. MARA—Wire rope is made in Canada, but there are aerial tramways suited for mountain districts that are not made in Canada, and no mountain company would purchase an aerial tramway made in Canada when they can get one that is peculiarly suited for their work.

HON. MR. IVES—Are not diamond prospecting drills made in Canada?

MR. MARA—Some are, but there are modern inventions for prospecting that are not made in Canada. Only a short time ago one was imported, and the party who imported it would not have gone to Chicago if he could have got what he wanted in Canada.

HON. MR. WALLACE—The Government's policy has been to put the most liberal construction on the item in the tariff, admitting free mining machinery of a kind or class not manufactured in Canada, while, of course, safe-guarding the revenue as much as possible. There are a great many implements used in mining operations which, of course, are made in Canada, and upon which a duty has to be levied if they are imported. For instance, steam engines are required for operations at the mines, and those steam engines of almost every class and character are made in Canada, and are dutiable if imported, and I believe they can be made as cheaply in Canada as in almost any other country. Then, all such implements as picks, shovels and spades are of course made here. Of the articles which the hon. gentleman has mentioned, a large proportion will, I think, come in free of duty; for instance, ore sampling machines, concentrating and amalgamating machinery, stamp mills, ore breakers and water jacket furnaces; these are not made in Canada, I think. But when it comes to piping and articles of that kind that are made in Canada, and which can be made probably of a superior kind, that would be in contravention of the Act as it now stands.

MR MARA—Is there any hydraulic piping made in Eastern Canada?

HON. MR. WALLACE—It would be more likely to be made in British Columbia, because that is the place it would be in demand. The department has decided, on the advice of the Department of Justice, that the machinery for extracting ore from the rock will be correctly classified as mining machinery. Also the machinery that conveys the ore to the surface, and also the machinery for treating it when it arrives. Those three classes of machinery having been declared free, under this clause as mining machinery, I think a very liberal construction has been placed on the Act; and the fact that, during those three years, a quarter of a million dollars worth of machinery has been imported, and last year about $88,000 worth, shows that mining operations are being more vigorously prosecuted and that advantage has been taken of this free importation.

HON. MR. FOSTER—I would suggest to the hon. gentleman whether the amendment he proposes would not tend to narrow the scope of the resolution. I would suggest to my hon. friend that he could have the very same certainty, without narrowing at all the application of the free clause, if the Controller of Customs would make a list of those items of machinery, as to which there is no doubt, and some of which the hon. gentleman has mentioned in his amendment, and forward such list to the different collectors. This list would include all those articles which it is certain are not made in the country and be forwarded to the different collectors, so that the instructions to the collectors

would be positive and not negative, and whenever a piece of machinery of the kind mentioned was imported, the collector could be in no doubt as to its right to free entry. The hon. gentleman would gain everything he desires to gain, and would not narrow the scope of the resolution by attempting to define, in the law itself, the particular articles which it covers. I think the Controller of Customs would have no objections at all to make out a list, and if the hon. gentleman will submit any others that are used in his portion of the country, the Controller could go into the matter with him, and arrive at a positive list of those which could be admitted free.

MR. MARA—My object was not in any way to limit the scope of the free admission of mining machinery, but rather to let the miner and the capitalist see at a glance that the articles I have enumerated would be admitted free of duty. The trouble heretofore has been that a list was furnished to the collector which was issued by the manufacturer, and that list was so cunningly worded that it covered nearly every article of mining machinery made. When an application was made for free entry, the collector would refer to this list, and ten to one he would find in it an article of the class, but not of the kind which the importer wished to pass free of duty. I therefore thought that by making out a list, the miner could see at once what machinery he could bring in free of duty and so would the capitalist, and both would be saved the uncertainty and expense they have been subjected to in the past. However, if the Government will allow a list to be sent to the different collectors, embracing all classes of mining machinery, not made in Canada, and substitute that list for the present one, I think the proposition is better than mine and would most gladly withdraw my amendment.

HON. MR. WALLACE—Why not send both?

MR. MARA The present list is misleading. For instance, it says in one case machinery for iron and other minerals. If that means any thing at all, it means all other minerals.

HON. MR. FOSTER—A positive list would be far more satisfactory.

HON. MR. IVES—Would you not meet with this further difficulty, if you mentioned the machines made by these particular makers. This tariff is made, I hope, for a good many years to come, and you will simply have the power to bring in these certain machines, whereas something a great deal better might be made by some other maker and this would be excluded.

MR. MARA—I simply asked that these articles be added, without restricting or limiting, or in any way affecting the preceding paragraph, admitting mining machinery of all kinds, not manufactured in Canada.

Amendment withdrawn.

Coal Shipments from Old Sydney Mines.—The shipments of coal from the Old Sydney mines of the General Mining Association, Ltd., were 25,000 tons last month.

Nickel—Its History, Uses and Distribution. *

By MR. A. G. CHARLETON.

The subject of this paper is one which the author begs leave to present, thinking that it may be profitably considered. His own interest was awakened in nickel some years ago when making an inspection of an important group of nickel mines, and the works connected with them, in Germany, but the superior attractions of gold and silver mining have prevented him till now from reviving it. The discovery that nickel was a new element was made by Cronstadt in 1754, and he named it after the mineral *kupfer-nickel*, in which it was discovered by him, but it was reserved to Bergman, in 1779, to show that nickel was really a new metal. Kupfer-nickel was described by Hierne in 1694, and its name indicates the low value set upon such ore by the German miners in those days. Kupfer-nickel, in fact, might be freely translated into English as Old Nick's copper, the term nickel being probably derived from the Low German "nikker," which stands for the devil or hangman.

Deceived by the copper colour of the mineral, the miners no doubt mistook it for copper ore, and probably gave it the name to warn future generations against what they, not unnaturally, regarded as a fiendish imposition on them. The miners, however, would no doubt tell you that it was due to the metallurgist's command of bad language, as they discovered that when cobalt ores became over-roasted in the manufacture of smalt the nickel they contained followed the former metal, and, combining with the silica, spoilt the blue colour of the glass the makers wanted to produce. To quote a most instructive paper on nickel by Mr. W. T. Austin, one may say that "nickel has not received from scientific men the attention to which it is entitled, and the subtle influence exerted on the physical properties of its alloys by the admixtures of exceedingly small quantities of other elements have mystified the practical man (so called by courtesy), and kept him in the background. For more than a century nickel puzzled and perplexed all who had anything to do with it, and its history is a long story of contradictory statements and mistakes." It seems to me it is a capital metallurgical illustration of the proverb, "Give a dog a bad name." But, granted so, a bad dog may sometimes be broken in, and become of service to its owner.

The literature dealing with the subject is exceedingly scanty, on the one hand because the properties of the metal have been insufficiently studied by those who would naturally be expected to investigate them from an economic point of view, and on the other because the interest of pure scientists in this field has for some reason lain dormant. Another cause is the secrecy maintained for so long a time by those manufacturing nickel products with regard to their processes and methods. This policy, which, it is to be presumed, has generally for its object the idea of deterring competitors from entering a special field, is surely a short sighted one, as it may well be doubted whether manufacturers are ever benefited in such cases by jealously excluding the scientific discussion of their methods of treatment, experience in the rapid development of the iron and steel trades, in one instance at any rate, going to prove the benefit of adopting an opposite policy.

Nickel has certainly maintained a high price in the past, but at the cost of an exceedingly limited consumption of the metal, and the original discoveries of ore in Scandinavia, Germany, and the United States furnished the trade for many years. It was only with the increased demand for the metal, induced by its more extended applications, that prospectors began to busy themselves and look around for larger supplies of ore, and the result has been the discovery of most important new fields, like those of New Caledonia, and Sudbury in Canada.

Austin traces four marked stages of development in the modern history of nickel. First, the century or more when the presence of some unusual metallic combination was recognised to exist in certain minerals, during which time the metal was introduced into the arts as an alloy known an "white copper," consisting chiefly of copper and nickel with a small proportion of zinc, closely resembling silver, tough, easily worked, and not tarnishable when exposed to gases containing sulphuretted hydrogen. Secondly, the period which commenced with the manufacture of German silver on a large scale at Berlin (about the year 1824), when nickel obtained a recognised position, Brandes having shown, the year previous, the exact composition of the new alloy. Up to 1838, nickel was wholly derived from its arsenide ores, and it was not till then, when Berzelius is thought to have discovered nickel in the Kleiva ores (Sweden), that Aschen made his first smelting experiments upon the nickeliferous pyrrhotites and pyrites of that country. The metallurgical losses were at first heavy, but between 1849 and 1851 Berdberg laid down certain principles, which have held good in nickel metallurgy up to the present time. Thirdly, the period which dates about this time (1850, when Switzerland adopted nickel for subsidiary coins) marks another era in the history of the metal. In 1888, it was first successfully alloyed with steel on a scale of commercial importance, and this has given nickel a fourth periodic impulse, which has only just practically commenced, and promises to far exceed all the preceding ones in its results.

The world's production of metallic nickel has increased within the past ten years from 1,000 tons per annum to over 5,000 tons, whilst previous to 1876 not more than 600 tons were produced in any one year. As far as our knowledge at present extends, the principal value of nickel seems to lie in the properties of its alloys. For example—(1) German silver is of such general utility that articles made of it are everywhere to be found in household use. (2) Alloys of nickel and copper have largely supplanted the smaller silver comage of several European countries and America. (3) A small percentage of nickel, incorporated into steel, has provided the engineer with a structural material superior, for many purposes, to the best carbon steel made. (4) Pure nickel, in the metallic form, is used for plating other metals; and though its cost is at present too high to admit of wide use, it is employed for making numerous small articles.

To give one instance only. A short time back the interest aroused in me by nickel, combined with the conviction that silver, under existing international currency conditions, at even 29¾d. an ounce, was an extravagant luxury, induced me to extend the application of nickel, by having a cap of it set on the handle of my old but valuable umbrella. Austin predicts that nickel will be put into the form of ferro-nickel, suitable for making commercial steel, at no distant time, in not more than three operations, without innumerable bye-products being left over to work afterwards. At present, the simplest and most direct method of treatment includes at least seven distinct stages—roasting, matting, Bessemerising—after which it has to be "topped and bottomed," refined, reduced to oxide, and finally incorporated, not to mention all the side operations of working up the bye-products. It is a subject indeed to which English metallurgists might, in all probability, profitably turn special thought.

Before the Christian era, nickel was employed for coinage purposes by the Bactarian king Euthydemos, 235 years B.C., and analysis of these coins shows that they were evidently intended to contain 22 to 23 per cent. of nickel to 77 or 78 per cent. of copper, closely approximating, curiously enough, the proportion of 25 to 75 per cent. which experience has taught us is the most desirable admixture of these metals for use in coinage. It is remarkable that Euthydemos hit upon this particular ratio of copper to nickel, and the fact that analysis shows no arsenic debars rich arsenical ores from being a source from whence the nickel employed was derived, and points to the use of sulphides, as the silicates could scarcely have been treated at that time. If this be so it indicates considerable metallurgical skill on the part of the early smelters, and, considering the nature of the metals employed, it is hardly probable the alloy was a haphazard mixture. Professor Roberts Austen mentions also that, long before Europe awoke to the value of nickel, that enterprising person, the heathen Chinee, was making an alloy of nickel, and shipping it to Europe for a century or more, under the name of Pack Fong, * or white copper. Just before the commencement of the second period, before alluded to, nickel appears to have been discovered in the United States, when Seth Hunt opened up the cobalt mines near Chatham, Connecticut, and shipped some of the ore to England, where it was reported upon and stated to contain nickel. These mines, in 1854, were said by Whitney to be the principal sources of American nickel, but, from the fact that they were repeatedly taken up and abandoned, they no doubt proved commercially unremunerative.

The principal deposit of nickel opened up to date in the United States, the celebrated Gap Mine, appears to have been discovered somewhat later, viz., in 1718, and was being worked for copper in 1744. It was not, however, till 1852, when the property came under new management, having proved unsuccessful as a copper proposition, that investigations began to be made as to the nature of the yellow sulphide ore, looked upon as worthless mundic by the former owners, and thrown by them over the dump. The first tests were not conclusive, but, in 1853, Dr. Genth, of Philadelphia, pronounced it to be millerite. During the third period in the history of the metal, in 1862, Joseph Wharton acquired the Gap property, and put it into operation as a nickel producer in May, 1863, starting a refinery at Camden. At the Centennial Exhibition in Philadelphia, in 1876, Wharton made an exhibit of nickel products, such as had not been seen elsewhere up to that date; and in 1878 he showed articles made of pure nickel, both forged and cast, which were so remarkable that they excited at first considerable incredulity.

In 1804, Richter had succeeded in producing malleable nickel, but subsequent investigations met with very variable results, through neglect in recognising the important part played by small quantities of impurities alloyed with the metal. A new future for nickel as a metal, apart from its alloys, dawned when, in 1879, Fleitmann found that by the introduction of small amounts of magnesium just before pouring the quality of the nickel was improved; Garnier subsequently accomplishing the same end by the use of phosphor-nickel. This third period is likewise marked by the important event of the discovery, in 1876, of immense quantities of hydrated silicates of nickel and magnesium (garnierite) in New Caledonia, which placed an exceedingly valuable material at the disposal of manufacturers, opening up the possibility of producing a purer nickel from ores free from the usually accompanying deleterious substances, reducing the price of the metal, and extending its uses. Nickel ores had been discovered in the island some years previously, but it was not until 1876 that they began to influence the market. These new ores contained the

* Abstract of a paper read before the London Society of Arts, May, 2, 1894.

* According to an analysis of a specimen in Dr. Percy's collection at South Kensington, composed as follows: Copper, 4'4 per cent.; zinc, 25'4 per cent.; nickel, 31'6 per cent.; iron, 2'67 per cent.

nickel in the form of protoxide, free from cobalt, copper, sulphur, and arsenic, and consequently required an entirely different system of treatment from that by which the sulphide and sulpho-arsenide ores have been handled. Some years previous to the appearance of the New Caledonia silicates at the metallurgical works of Europe, somewhat similar ores had been worked at Ickatarinenburg, in Russia; others were known to exist in Spain; and since then further deposits have been found in Oregon and North Carolina. In 1876, the production of the Scandinavian mines reached its maximum height, the yield of Norway being 360 metric tons of metal, and that of Sweden considerably less than 100 tons. Since that date the production of this district has very considerably declined.

Nickel silicates were discovered in Douglas county, Oregon, in 1881, and have lately been exploited by an Anglo-American company, whilst in 1884 deposits of nickel ores were proved to exist in Churchill county, Nevada. The Pacific Coast mines are said to be the most promising deposits at present known to exist within the boundaries of the United States, but distance from market, and the discovery of nickel in Canada, have militated against their development. In 1856, Mr. Alex. Murray pointed out the occurrence of a dingy green magnetic trap at a point 10 miles south-west of what is known as Sudbury in Canada, and this rock, upon analysis, showed small quantities of nickel and copper. The first discoveries of any commercial importance were not made until the building of the Canadian Pacific Railway in 1883 and early in 1884, when a cutting on the line pierced a small hill about 3½ miles south-west of Sudbury, exposing the deposit since known as the Murray Mine. In the spring of 1886 the Canadian Copper Company was formed to operate the Copper Cliff (Stobie & Evans' mines), but it was not till 1888 that the company erected their first furnace. Shortly afterwards a number of companies entered the field, amongst others Vivian & Co., of Swansea. These Canadian mines, which are in the districts of Algoma and Nipissing, in the province of Ontario, have of late years attracted world-wide attention; first, on account of their apparently inexhaustible character; lately, because of the new applications of nickel in the manufacture of nickel steel. One is apt to overlook nickel in its mineralised forms, and the Sudbury ore bodies were originally opened as copper mines.

The unusual properties displayed by meteoric iron, in regard to its extraordinary toughness, and in some instances its non-corrodibility, coupled with the fact that it is invariably associated with nickel and other elements, has of late years drawn attention to the influence which nickel exerts when alloyed. Farraday, Berthier, Longmaid, Liebig, Fairbairn and Boussingault Künzel, and even Ledebur, all investigated the subject, but all efforts to manufacture a valuable alloy of iron and nickel were in vain until a few years ago, when the fourth era of nickel commenced. The trouble was that the immense influence of minute quantities of other accompanying metals and metalloids was unsuspected. Probably, the first appearance of nickel-iron alloys in the United States was when Philip Thurber, of Detroit, exhibited some products of the iron furnace at Marquette, Michigan, at the New York Exposition in 1853. This iron was made from a nickeliferous limonite, and possessed some remarkable qualities, but it was not till 1888, after experiments had been made by Marbeau, in France, with crucible nickel-steel alloys, that James Riley took the subject up and began experimenting in Scotland with similar manufactures produced in the open hearth, and convinced himself and the metallurgical profession of the genuineness of the claims advanced for this new material. The results are given fully in a paper read by him at the Glasgow meeting of the Iron and Steel Institute, May, 1889.

Notable among these was an alloy containing 4·7 per cent. nickel, which showed an elastic limit of 28 tons per square inch and a breaking strain of 40 tons, whereas similar steel without nickel showed only 16 tons and 30 tons respectively. The elongation and contraction of area of this steel were not, moreover, materially impaired. In a series of competitive armour trials made at Annapolis, Maryland, in September, 1890, the palm was awarded to a French nickel-steel plate, and Mr. Tracey, at that time Secretary of the U. S. Navy, gave orders to have further trials of similar material made, which had been manufactured of American material by American mills, with a view to decide the best material for protective armour for the new men-of-war being built. These tests, as reported by Mr. W. S. Abbott, of Messrs. Carnegie, Phipps & Co., gave an ultimate tensile strength of 100,000 to 102,000 lb. per square inch, with an elastic limit of 59,000 to 60,000 lb. The elongation was 15½ per cent., with a reduction of area of 29½ and 26½ per cent. respectively at fracture.

The toughness of nickel steel is shown by the fact that blocks cut from the armourplates at Bethlehem, many of them weighing several tons, cannot by any method yet devised be profitably broken up into sizes suitable for returning them to the furnaces. It is stated also that experiments lately made by the German Government show that shells exploded in ordnance made of ordinary steel badly injured it, whilst with nickel steel it was only enlarged. One by one the objections raised against nickel steel have been removed, the effect of cold weather on the plates, for instance, having been experimentally demonstrated to be of no consequence, if one may judge from a series of experiments carried out at the United States navy yards since 1891.

The tough tenacious material flows under the impact of the shot, and in the case of Harveyised, *i.e.*, surface-hardened plates, the extreme hardness of the exterior, reinforced by the tough untreated steel behind, shatters the forged-steel Holzer projectiles, which have hitherto proved irresistible. These shells are made, I believe, of highly-carbonised steel, containing 0·8 to 0·94 of carbon, and, in addition, 0·94 to 2 per cent. chromium. Nickel steel is practically incorrodible, and can be advantageously made on the basic open-hearth furnace. Professor Roberts-Austen states that nickel has an atomic weight of 58·60, atomic volume of 6·7, specific gravity of 8·80, specific heat 0·110, melting point 1,600, coefficient of linear expansion, 0·0000727; electric conductivity, 7·374. Quoting the investigation of Riley, he gives a diagram which shows that nickel up to 7 per cent. materially increases the tensile strength of steel and elastic limit, while its extensibility is as rapidly diminished.

Though there has been no material increase in the established channels of consumption, except it be for plating, whilst 1,000 tons of nickel flooded the market in the early days of the century, 10,307,275 lb., or, roughly, five times as much, was produced in 1891, consequently the large excess of metal produced must have gone into nickel steel, yet this alloy has scarcely begun to be used in the arts of peace. As its price tends steadily downward, we many confidently expect that it will eventually enter into competition with other materials for other purposes than armourplates and guns. Though there is always naturally some hesitation in adopting a comparatively untried material, where it is subjected to extremes of temperature, such as for boiler plates, bridgebuilding, and marine engineering, experiments are going on all around us, and last year it was decided to place sections of nickel-steel propeller shafting in the U.S. protected cruiser *Brooklyn* and the battleship *Iowa*. The ordinary carbon steel used for such purposes has a tensile strength varying from 60,000 to 65,000 lb. per square inch, whereas the nickel steel will show a tensile strength of 90,000 lb. per square inch, the elongation in both cases being about the same, 20 per cent. Using this stronger steel will warrant boring out the shaft, materially lessening the weight whilst preserving its efficiency, and such cored shafting can be hollow forged when the hole is large enough to admit a mandril.

If it is found possible to apply it to the construction of boilers, the tensile strength of nickel steel being 1½ time that of ordinary steel, it will enable their thickness to be reduced one-third, effecting a saving in weight, which is often a great consideration. Jules Garnier gives in *Le Genie Civil* the results of a series of tests made in 1892, at the Cleveland Rolling Mill Company's works, on nickel steel. The nickel was produced at the Brooklyn Nickel Works, from Sudbury ore, by the Canadian Company. The deductions drawn from a comparison of the results of these trials with others obtained from ordinary steel made and tested under identical conditions are:—1. Nickel steel has a higher elastic limit of some 11,400 lbs. per square inch, or nearly 31 per cent. more than ordinary steel. 2. The tensile strength of nickel steel is greater by some 10,400 lbs. per square inch, or an increase of about 20 per cent. 3. The ductility of steel is not reduced by the presence of nickel.

During last summer the Bethlehem Ironworks completed a spare shankshaft for the American liner *Paris*, using nickel steel of about 90,000 lb. tensile strength, which is said to be 25,000 lb. in excess of any German or English manufactured steel, with the exception of the material turned out by one firm in this country, which has adopted steel of a similar character. Another important channel of consumption is the manufacture of a nickel-copper alloy (Ni 20 per cent., Cu 80 per cent.) for casing bullets to be used with smallbore rifles, now adopted by all the armies of Europe. This alloy has a higher degree of tenacity than the best brass, combined with a higher co-efficient of elongation. The possibilities opened up by the uses to which nickel alloys may be applied by engineers in different branches of business may well attract the attention of miners and capitalists to deposits from which supplies of the metal can be got. The ores of nickel include the following minerals:

Sulphides.

	Nickel Per Cent.
Millerite, NiS	64·6
Polydymite, Ni_4S_5	59·4
Beyrichite, Ni_3S_4	54·2
Pentlandite, (FeNi)S	34·0

Arsenides and Sulpho-arsenides

Niccolite, NiAs	43·9
Rammelsbergite and Cloanthite, $NiAs_2$	28·1
Gersdorffite, NiAsS	35·4

Sulpho-antimonides.

Breithauptite, NiSb	32·8
Ullmanite, NiSbS	27·8
Wolfachite, Ni(AsSb)S	29·8
Coryite, Ni(AsSb)S	28·8

Silicates.

Genthite, $2NiO.2MgO.3SiO_2.6H_2O$	22·6
Garnierite, $H_2(NiMg)SiO_4 + Ag$	25·0
Connarite, $H_4Ni_2Si_3O_{10}$	31·4
Rewdanskite, $(NiFeMg)_3Si_2O_7 + 2H_2O$	28·1

Sulpho-bismuthide

Kallilite, NiBiS	19·0

Telluride.

Melonite $NiFe_3$	23·8

Oxides and Salts.

Bunsenite, NiO	78·5
Nickel oxide, Ni_3O_4	73·1
Morenosite, $NiSo_4 + 7H_2O$	20·9
Annabergite, $Ni_3As_2O_8 + 8H_2O$	29·4
Cabrerite, $(NiMg)_3As_2O_8 + 8H_2O$	25·1
Forbesite, $H_2(NiCo)_2As_2O_8 + 8H_2O$	14·4
Lindackerite, $3NiO.6CuO.So_3.2As_2O_5 7H_2O$	12·9

Carbonate.

Zaratite, $NiCO_3.2Ni(OH)_2 + 4H_2O$	46·8

It may be mentioned that millerite has been found in Iowa forming tufts of beautifully arranged needles, in large, perfectly transparent crystals of calcite, in the compact lower carboniferous limestone of the Keokuk quarries, some 20 feet below the "geode-bed;" in cavities running up to 20 inches in length, thickly set with rhombohedrons of this peculiar character.

Geologically, nickel ores are equally divided into three main groups, which broadly correspond with the following classification. Vogt has employed this subdivision as a foundation for a genetic classification. His groups are: (1.) Arsenides, which include sulpho-arsenides and sulpho-antimonides, as well as combinations of the metal with sulphur and bismuth. (2.) Sulphides, such as nickeliferous-pyrrhotite and pyrites, millerite, &c. (3.) Silicates, garnierite, genthite, &c. A brief description of a few typical examples of each group is interesting, as throwing light on the general occurrence of the ores of this metal.

The first of these groups is found in veins in Hungary, of the Dobchau type, and in the so-called Kobaltrücken, typified by the Richelsdorf Bieber veins. They occur also (as subordinate minerals) in the silver-bismuth-cobalt veins of Schneeberg, in the ordinary silver-lead veins of Freiberg, and in the Gem mine of Fremont, Colorado. In addition to nickel cobalt ores of various kinds, Von Groddeck shows that the typical Dobschau veins carry copper, and all these three metals are found in the serpentines and older eruptive lime-olivine rocks, which form the country of the veins, and appear to have been produced from the decomposition of the adjacent rock masses, composed of olivine and gabbro. A vein of this class is found at Dillenberg in Nassau, in pickrite, altered to serpentine, and contains millerite, bismuth-glance, pyrite, and other sulphide minerals. This vein was only productive in the serpentine, becoming barren when it passed into the adjoining schaalstein country. The gabbro in the neighbourhood of Dobschau, which has been partly altered, as before mentioned, to serpentine, is fringed by a peculiar green silicious schist, resting on gneiss and granite. The veins occur between the gabbro and the schist, do not possess well-defined walls, and often reach a width of 25 feet. The Schneeberg deposits, which likewise belong to this group, have a special interest for me, as I visited the district in 1880, and had an opportunity of examining its geological features, although my attention was more particularly directed to a study of the methods of dressing these ores, which present particular features of interest in their details. The veins chiefly occur in mica-schist, which passes into clay-slate, more rarely entering the deep-seated underlying granite, which, along with basalt, is found in intrusive masses, penetrating the overlying formation in the neighbourhood of Schneeberg.

The chief group of nickel cobalt veins lies around Neustadtel, and, in general, strikes from N.W. to S.E., the dip being in some cases N.E., in others S.W., but in all cases highly inclined. The gangue is called by Von Cotta hornstone, and they carry, in addition to nickel and cobalt, bismuth, copper pyrites and silver. He considers them to be veins of infiltration, formed by percolating mineral waters. Closely connected with this system of veins is an independent group of copper lodes, which strike N.E. and S.W., with an almost vertical dip to the N.W. These show a great variety of copper and other minerals, amongst which may be named copper pyrites, bornite copper-glance, tetrahedrite, cuprite, tenorite, chrysocolla, malachite, azurite, galena, cupreous sulphur of lead, cerusite, pyromorphite, iron and arsenical pyrites, blende, native silver, jasper alophane, diaptase, barytes and brown-spar, a veritable mineralogical museum. The nickel-cobalt ores as they are delivered to the dressing works average, I am told, 4 to 6 per cent. of cobalt, 3 per cent. of nickel, and 8 to 10 per cent. of bismuth.

The second or sulphide group of nickel deposits embraces those of Sudbury, Ertali, Piedmont, Varallo, and other places, and possesses very wide distribution, and marked geological characteristics. Vogt assumes this class of deposits is usually formed by a process of differentiation, or segregation from a basic eruptive rockmagma, and they are distinguished by the peculiarity that the ore chiefly consists of pyrrhotite, which carries, disseminated through its substance, various nickeliferous sulphide minerals, such as millerite, polydymite and pentlandite, while chalcopyrite and titaniferous iron usually accompany the iron pyrites as accessory minerals. The largest and best known deposits of this class are at Sudbury, in Canada, where the ore is found in irregular, lenticular masses in the Huronian rocks, apparently conformable to the planes of bedding, and invariably in proximity to dykes or uptilted sheets of greestones (diorite) and diabase. From the fact that the greenstones themselves are found at times with ore disseminated through them,

Merritt thinks the nickel has been brought to the surface by the agency of these dykes. The region has been much faulted, and in places the pyrrhotite and chalcopyrite form a breccia, in a dark, chloritic matrix. The main range is about 50 miles long, and one to five miles wide, running N.E. and S.W. from Lake Wahnapitae to the Spanish river. The nickel deposit outcrops are described as forming hills or ridges.

According to Mr. D. W. Browne, the ore frequently loses the character of a copper ore, which it possesses at surface, becoming more and more nickeliferous, and less cupriferous in depth. To illustrate this, he cites the Copper Cliff Mine, stating that on the fourth and fifth levels the ore carries 4 per cent. of copper, and 4·5 per cent. of nickel, while on the seventh level many "stopes" show an average of 0·5 per cent. Cu, and 8 to 10 per cent. Ni; the evidence, however, so far, would hardly appear to be sufficiently extended to warrant any general conclusions of similar enrichment, in other cases, taking place, founded upon what may turn out to be an exceptional occurrence.

As far as the Sudbury deposits have been exploited, down to a depth of 600 feet, there is no sign of falling off in the grade or quality of the ore. It contains in bulk 1 per cent. to about 5 per cent. Ni, and 1 per cent. to 4 per cent. Cu, and cobalt, traces of gold and silver, and platinum in the rare form of sperrylite (arsenide of platinum) is found in it. Mr. Argall, of Denver gives the following analyses of an average month's out of the Copper Cliff, Evans, and Stobie mines, to illustrate the ratios between the nickel and copper contents of the ore:—

	Copper Cliff.	Evans.	Stobie
Cu	4·31	1·43	1·02
Ni	5·57	3·74	2·36

A division of value is effected in the ore simply by screening. Thus at the Evans mine it is found:—

	Per Cent. Cu.	Per Cent. Ni.
The coarse ore carries	1·62	3·45
The raggings	2·99	3·90
The fines	3·78	5·64

The ore is sorted by hand into four grades—1st, the average mixed ore (nickel copper); 2nd, copper pyrites; 3rd, pyrrhotite or nickel ore; and 4th, gangue. The closeness with which this separation can be made is shown by the following results:—

Mixed Ore.

	Cu per cent.	Ni per cent.
Copper Cliff	5·67	4·75
Stobie	2·21	2·28
Evans	2·60	4·00

Picked Copper Ore.

Copper Cliff	14·13	2·74
Stobie	15·71	1·28
Evans	13·86	1·34

Picked Nickel Ore.

Evans	0·80	8·12
Copper Cliff	0·49	5·36
Average chlorite rock	0·80	0·70

This table shows that the pyrrhotite carries the principal nickel value, in comparison with which the chalcopyrite is quite lean, and that these ores are not intimately admixed.

The report of the Ontario Bureau of Mines shows that eight mines operated by four companies produced 85,790 tons of ore, which probably cost about $5 a ton to produce in 1891. The whole lot averaged 2·62 per cent. nickel; therefore the nickel in the state of ore cost about 10 cents per pound. The cost of succeeding operations to produce one ton of nickel oxide, containing 76 per cent. of metallic nickel, may be estimated to be $140.74, dealing with these pyrrhotite ores. Its mining and transport can be reckoned at 10 cents per lb.; conversion into oxide, 9 cents; reduction into metal, 8 cents; and allowance for loss in working, 4 cents; total, 31 cents per lb. Vogt endeavours to trace a constant ratio between nickel, pyrrhotite and chalcopyrite occurring in ore deposits in certain rocks, stating that, while in each mine the ratio may vary from day to day, the ore ratio over a long period will give constant results. He gives a table showing the ratio for eight of the principal mines in Norway and Sweden. In them the copper contents corresponding to 100 parts of nickel vary from 20 to 80 and average 43; while the nickel and cobalt contents in 100 parts pure pyrrhotite vary from 2·5 to 7·5, and average 3·8. Thus he claims for ores produced by a segregative process, from one and the same eruptive, such as norite, there is a ratio between the proportion of nickel to copper on one side, and the absolute nickel contents of the pure pyrrhotite on the other. The higher the nickel contents of the pyrrhotite, just so much lower is the ratio of copper to nickel. This phenomenon cannot have occurred by chance, but results probably from the relation existing between the small contents of Cu and Fe held in the silicates of the original eruptive magma.

Mr. Brown has determined that the nickel exists, in the pyrrhotite of the Copper Cliff and Evans ore, chiefly as pentlandite ($NiFe)_9S_8$, two-thirds of it being in this mineral form, and he ascribes the enrichment of the ore in depth to the increased amount of pentlandite found in the pyrrhotite of the deeper levels. He claims that the finer grained the ore is the more the nickel exists as an element, replacing the iron in the pyrrhotite, while experience has shown that the coarser grained the ore, and the deeper it lies below the surface, the more it occurs as pentlandite with the pyrrhotite.

Mr. S. H. Emmons recently described three new nickel minerals, which he discovered in the Sudbury ore, viz., folgarite, found at the Worthington Mine, having a composition represented by the formula NiS_2FeS; bluette, discovered in the workings of the Emmons Company's mines, composition $NiS_2 \cdot 12FeS$; and whartonite, found at a mine seven miles south-west of Sudbury, supposed to have the composition $NiS_2 7FeS_2$. In the Gap Mine of Lancaster, Pennsylvania, we have another example of a nickel-sulphide ore, consisting of millerite associated with pyrrhotite, impregnating a lenticular mass of hornblende rock, embedded in mica schist at or near their planes of contact. It has been suggested that this hornblende mass may prove to be an altered eruptive, while it is not unlikely that an adjoining trap dyke had some influence in the formation of the ore body. According to Blake, the ore runs 1·5 to 2 per cent. Ni, whilst Wharton averages it from a series of his analyses at 3·6 per cent. Ni and Co., and 0·75 per cent. Cu.

For a third example, we may turn to the Norwegian pyrrhotite deposits, in which the ore occurs chiefly at the contact of the eruptive norites (massive hypersthene gabbros), with the archean country schists. It has been pointed out by Stephen Emmens and others that the plane of contact between eruptive and sedimentary or metamorphic rocks offers a favourable passage for the circulation of mineral solutions. The Munkjar Mine represents a familiar ore deposit of this type, such as is usually assumed to have been so deposited. The norite body is 243 feet long by 135 feet wide, and is almost entirely surrounded by an irregular deposit of pyrrhotite, from 3 to 6 feet thick.

The third or silicate group of nickel deposits are best represented by those of New Caledonia, which have been described recently in a paper read by Mr. J. Garland before the Institute of Mining and Metallurgy, and by other writers. M. Heurteau, I believe, made a detailed geological survey of the island in 1873, which led to mining operations being commenced. The base of New Caledonia seems to consist of a light coloured non-fossiliferous schistose rock, on which secondary and tertiary rocks rest, and about one-third of its area appears to be covered by massive serpentines, which are most prominent in the east and south-east parts of the island. According to M. David Levat, the nickel occurs solely in the form of magnesian hydrated silicates of a beautiful apple-green colour when pure, as coatings or concretions, in the fissures of the serpentine, and he concludes, from the absence of arsenides or sulphides of nickel, that their mode of occurrence points to the deposition of the ore from solution in the state in which it is now found. The pure mineral, he reckons, often averages 20 per cent. Ni, but the average ore, after sorting, does not carry over 10 per cent. mixed with some serpentine gangue. Garland puts the average quality of the ore shipped to Europe at only 7 to 8 per cent. of metallic nickel, stating that ore of less than 6 per cent is considered unmarketable, and cannot be sold. The darker green the colour of the silicates, the richer the ore seems to be, some specimens appearing to shade off into almost pure silicate of magnesia, which is almost white, containing only traces of nickel. M. Peletan has found cleopters enclosed in crystals of the green silicate.

This green silicate is not, however, the only form in which nickel ore occurs in the district, as most valuable deposits are found of a brown mineral, of nearly the same composition, which Mr. Garland states is generally the richer of the two. It seems to consist of green silicate, in which part of the magnesia is replaced by hydrated oxide of iron (limonite), which gives it this brown colour. Treated with dilute hydrochloric acid, the iron is dissolved out, leaving the green mineral garnerite, which shows that the iron is not chemically combined, but merely mechanically associated with it. The deeper brown it is, the richer the ore is reported to be. This is remarkable, and points again to the fact before remarked, that association with iron appears to affect the nickel contents of the ore in a favourable way. This brown ore has a very light specific gravity, only 3·00, and Claudet gives an analysis of it as follows:—

	Per Cent.
Oxide of nickel (nickel = 9·64 per cent.)	12·25
Oxide of iron	32·2
Magnesia	3·07
Alumina	3·62
Silica	34·8
Water at 212° Fahr.	6·43
Water above 212° Fahr.	7·07
	99·44

The percentage composition of both the green and brown minerals varies greatly, and the above analysis may be presumed to be below the average, as Garland states that, omitting minor constituents, the average of twelve analyses of the green garnerite made by Professor Liversidge show SiO_2 44·75, NiO 19·73, MgO 15·25, and the Government year book for 1891 states that the richer mineral has sometimes the following composition:—Silica 45, nickel 26, magnesium 13, iron 3, water 13. I am also informed by Mr. Gregory that he found millerite in a sample of the ore from New Caledonia.

According to Levat the massive serpentine itself contains nickel in proportions varying from 1 to 3 per cent., and in some cases even 5 per cent. He further inclined to the belief that the protoxide of iron of the serpentines diminishes as soon as the nickel appears in them, and the total of the two metals remains constant, but when his paper was written he had not had the benefit of a microscopical examination to determine this. He lays great stress on the fact that the nickel ores, though found exclusively within the serpentine area, are not distributed there in an arbitrary manner, but always occur at or in the neighbourhood of certain beds of red clay (vasques), which Mr. Garland describes as looking in the distance like huge scars on the face of the hills. Levat says they appear black in the centre and red at the edge, when seen in the distance from the sea, and they are often ranged one above another like stairs on the flanks of the hills, giving a most characteristic profile. The former observer, however, denies their argillaceous character, stating that they contain practically no alumina, but consist almost entirely of iron and silica, with 1 to 3 per cent. of nickel, and he gives two analyses in proof of this contention. The existence of these basins of red clay, or earth, as they might perhaps (from what has been said) be more properly called, is certainly a most curious feature in the geology if New Caledonia, scarcely less extraordinary than that of the red pigs for which the island is said to be famed, and possibly the colour of the latter may have some connection with the presence of these red deposits on the island. So much of the island appears to be coloured red by nature that it seems quite a pity in fact it is not red on the map.

The clays or earths are believed by Levat to be the products of the hydrothermal decomposition of the serpentines, as they contain all the elements of these rocks, in addition to iron, manganese, chromium, and cobalt. He supposes that numerous iron and manganiferous springs found vent through fissures in the serpentine and have eaten it away, leaving half-dissolved masses of so-called sugar-rock in the clay that fills the basins, which in many places are capped by a deposit of oolitic iron ore, the product of the overflow of the ferruginous waters. Mr. Garland's observations that the ore is found in massive pieces in botryoidal, mammillated, and occasionally in stalactitic forms, and in brecciated masses, supports this view. It has been pointed out also as a remarkable fact that these deposits are mostly found at high altitudes (the mountains of the interior rising to a height of 5,576 feet, and averaging 1,640 feet), and in the lower lying serpentine areas they are non-existent; but I think it is capable of explanation, if we suppose that the serpentines are the altered products of volcanic action which overflowed in the interior of the island, as it is just there that the conditions would be found most favourable for the deposition of the minerals we have under review, under such circumstances. Veins of chrome iron ore also occur in the hard unaltered serpentines of New Caledonia,* whilst cobalt ore is likewise found in the red earths, the origin of which latter deposits is considered by Levat to be essentially hydrothermal. The chromium, on the contrary, he thinks pre-existed in the serpentine, and was derived from it, whilst the nickel solutions only appeared after the deposition of the clay.

These solutions, circulating not only on the contact, but in the cracks and joints of the adjacent serpentine, would explain the deposition of the hydrated silicon of magnesium and nickel, in "Stockwerk form," which is the most usual mode of occurrence. The nickel ore is, however also largely found, according to Levat, in a brecciated form on the roof or walls of the basins of red earth, being sometimes symmetrically deposited, when the axis of the basin is vertical (in which case the ore is of equal thickness on the walls); at other times the axis of the basin is inclined, and the serpentine which forms the roof is fissured, the cracks so found being often several metres wide, filled with rich ore, the nickeliferous solutions being unable to penetrate the clay and finding a natural passage along the walls of the cavities. Where the circulating waters moved for a long time between the walls and the clay, fine strix are found upon the latter. Levat further states that the nickel deposits lie in a series of zones, running north-east and south-west, starting from the east coast, penetrating into the interior, and continuing, as Mr. Garland points out, to the west coast; outside of them there are only local encroachments, which lack uniformity.

Though in 1887, at the time Levat examined them, the deepest workings were only down 275 feet below the outcrop, he concluded that in depth they would lose their thickness, basing his opinion on the probability that the red earths with which they appear connected would not hold down to any great depth. Levat summarises the general characteristics as follows:—1st, the ore is essentially dependent on the serpentine of the east and south-east parts of the island. 2nd, ores of cobalt, associated with manganese, are found in beds on the rim of the basins of the earth found traversing the serpentine in a number of places. These cobalt ores do not contain over 2 or 3 per cent. of Co, but they are very extensive, being mined simply by scraping up the material. 3rd, the deposits of chromium are of two kinds, either in veins in the serpentine or in stratified beds in the basins of earth. 4th, the nickel deposits are of later formation than either of the two preceding ones, and are situated exclusively at or in the neighbourhood of the contact of these clays or earths with the serpentine, and never in the body of the former. They are united in a certain number of north-east and south-west lines, the width of which does not exceed, as before said, 600 metres. The crystalline diallage, being less attacked than the other constituents of the serpentine by the mineral solutions which have eaten it away, forms a skeleton, which is sought for by

* At the Gasconne Mine the serpentines are particularly rich in chromite, occurring in veins in the undecomposed rock, but breaking off suddenly at the contact of the serpentine and clay.

the miners as an indication of ore. True lodes appear to be absent, but some of the fissures filled with ore can be traced for considerable distances along their strike, possess regular walls and dip, have a width of 18 inches to 5 feet, and have been followed down in one instance to a depth of 360 feet below the surface outcrop.

As the formation of the deposits in the basins of red earth is due, Levat thinks, to the shrinkage of those clays, their continuity in depth may probably depend, as he supposes, on the depth of the clays in the basins. It must not be supposed, however, that the deposits are likely to be speedily exhausted, as they have a very wide distribution indeed. They are mined in open quarries, in benches, when found as stock works; at other times, by tunnels and winzes. The work is commenced by removing the red clay, which, if mixed with the ore, entails difficulties, as the grains of iron are with great difficulty separated by washing, and consequently appear in the matte produced. Moreover, the clay, being very aluminous (according to Levat), renders the silicious ore still more refractory. The gravity system of transport on a single rope at these mines is certainly extremely primitive, but is no doubt due to the necessity of frequently shifting the position of the terminals. It might, however, be improved upon by hauling up the empty bags and carriers on a carriage attached to the main cable by means of a small hoisting rope, operated by a windlass, instead of carrying them up, as is now done, on men's shoulders. The principle of using gravity-inclines with double ropes has been satisfactorily employed underground at the Pierrefitte mines in the Pyrenees, in large open gunnices—the only instance I know of where such a system has operated underground. It was introduced because the flatness of the lode would have involved shovelling, and it possesses obvious advantages over an inclined plane for a short temporary roadway in lofty workings.

According to Mr. P. Argall (quoting, I believe, from official sources), the output of nickel and cobalt ore from New Caledonia in 1890 was 22,690 tons of (say) 10 per cent. nickel ore, and 2,200 tons of 3 to 5 per cent. cobalt ore, whilst in 1891 the output of nickel ore had only reached 35,000 tons. Mr. Garland states, on the other hand, that these mines are now producing over 60,000 tons of nickel ore per annum; and, to reconcile the two statements, I take it that he alludes to the crude ore. He puts the cost of mining at 6s. to 40s. per ton. The first mechanical treatment of the ore consists of sorting and washing at the quarries, where a division is made into rich ore, carrying 8 per cent. and over of nickel, and poor ore under that amount. The ore is then carried to the plain below to be washed, so as to remove the red clay. The nickel has the same specific gravity as the serpentine, but less than the iron. The ore rejected at the quarry, although it contains 3 or 4 per cent. of nickel, is of no value. Garnier's first idea was to treat the ore in a blast-furnace, to obtain crude nickel and refine it; but this latter process presented such difficulties that it was abandoned. Fusion for matte was then tried, but was also given up, owing to the high price of fuel and the inefficiency of the convict labour. The cost of producing metallic nickel, dealing with such ores, appears to be—mining and transport, 10 cents; conversion into oxide, 3 cents; reduction into metal, 8 cents; allowance for loss of working, 1 cent; total, 22 cents.

Deposits closely approaching in type those just described were discovered in 1881, at Riddles, Douglas, Oregon, and others of a similar kind have been found at Webster, North Carolina. The Riddles deposits all lie at or near the surface, in beds 4 to 30 feet thick, occurring as a boulder formation, scattered through a ferruginous earth or in beds underlaid by serpentine, and associated with chrome lime. Mr. F. W. Clarke has made a series of analyses, which shows that the relative composition of silicate minerals obtained from New Caledonia, Oregon, and North Carolina agree very closely in composition and appearance. A fresh specimen of "country" was analysed from Oregon, and some olivine was found in it. The rock contained 0·10 per cent. NiO, the olivine 0·26 per cent. NiO. This suggested to Clarke a profitable source of derivation of the nickel in the altered beds of ore, and the microscopical investigations of Diller confirm his view. He considers the Riddles rock as belonging to the peridotes. It is a holocrystalline, granular rock, composed essentially of olivine, whilst one-third of the rock mass consists of enstatite, with a small percentage of chromium and magnetite. Quartz is present from metasomatic change, and whenever genthite appears it is always associated with quartz or serpentine. The genthite occurs in the serpentine, directly connected with the grains of olivine, from which the serpentine has been derived, and Diller states there is every reason to think the genthite is primarily derived from the same source. Though the Webster rock (which is also a peridote, of the variety known as dunite) contains less enstatite, and the nickel silicates are not so closely intermixed with quartz, the relation of the genthide to the serpentine and olivine is the same as at Riddles. Of the New Caledonia genthite Diller says, like that of Oregon, it is disposed in layers and cavities thoroughly intermingled with quartz, and sections show the serpentine with traces of olivine and enstatite so disposed as clearly to indicate that the serpentine naumeite, and other secondary products, have resulted from the alteration of the peridote rock.

According to Mr. S. H. Emmens, the nickel deposits of North Carolina are found in veins of three classes—1st, those occupying fissures the strike of which is more or less normal to the planes of division, that give a bedded aspect to the chrysolite rock mass; 2nd, there are numerous caunter veins, with a strike oblique to the first series; 3rd, there are bedded veins, located in planes of division. He is of the opinion that the caunter and bedded veins will not be found very productive, and the first series will alone yield any considerable supply of ore. A nickel-iron josephinite has been lately discovered, in the form of pebbles and smooth boulders, in considerable abundance in the placer gravels of a stream in Josephine County, Oregon. They are supposed to have been driven from some dyke of ultra-basic rock.

Melville has described this alloy,* which is highly magnetic. The pebbles are a greenish black, with bright areas of a greyish metal. The greenish-black portion consist of silicates, some of which are indissoluble in HCl. Nickel is found in the Urals at Rewdinsk, in veins six feet wide, between chloritic schist and serpentine, as well as in a great many places in other parts of the world. At the Kelsey Mine, Los Angeles, Co. California, Ni and Co ores are found in the comparatively rare form of arsenates, together with silver-glance and native silver, in a fissure vein in close relation with a diorite dyke. The assorted ore contains 7 per cent. to 15 per cent cobalt, 2 to 3 per cent. nickel, and 1,000 to 1,400 ozs. of silver per ton. Rich nickel ore has been found in the Gem Mine, Fremont, Colorado, in a hornblende schist, occurring as an arsenide and sulpho-arsenide, some of the specimens being so permeated with fine wire silver as to be difficult to break. At surface the ores were mostly copper, but at a depth of 15 to 20 feet nickel was struck, and continued down to 75 feet, when the vein, which had averaged 3½ to 4 feet, cut out and appeared to be lost, but, on resuming sinking, a streak of ore about 18 inches wide was struck, containing the same minerals and supposed to be a continuation of it, though this has not been definitely proved. Small shipments of this ore ran from 12 to 24 per cent. nickel, and 2 to 4 per cent. cobalt; the last lot shipped to England contained most of the nickel as niccolite. The ore streak is unfortunately narrow, the walls hard, and the ore difficult and expensive to mine. Nickel is known to exist in the hornblendic rock near Salida, Colorado. The serpentines of the west of Ireland and Cornwall, and indeed almost all serpentines, contain a little nickel, and it is met with in Australia, New Zealand, and South Africa. Sufficient has therefore been said to show that nickel ores are widely distributed over the world, though in the present condition of our metallurgical knowledge of the subject, payable deposits are less numerous than those of most of the common metals.

(To be continued.)

* *American Journal of Science*, vol. xliii., p. 509.

The Limitations of the Gold Stamp-Mill. †

Mr. Rickard (communication to the Secretary): I wish to supplement the interesting remarks of Mr. Olcott by adding a few figures illustrative of some of those features of the stamp-mill to which he has made particular reference.

The consumption of iron by the wear of shoes and dies is dependent mainly upon the hardness of the ore crushed and upon the brittleness of the metal used. Table I. ‡ gives the results obtained at eight localities working under very dissimilar conditions:

The minimum wear of shoes and dies amounts to 7.1 oz. of iron per ton of ore crushed, while the maximum is 25.4 oz., the average of the eight districts being about 1¼ lb. Two facts are apparent from the examination of the tabulated figures. As would be expected, the life of the dies does not vary in an equal degree with that of the shoes for the obvious reason that the ore upon the die serves as a cushion, protecting it from excessive wear. When that cushion of ore is not properly maintained, we get "low feeding" and an excessive abrasion, due to the working of iron upon iron. The importance of a regular feeding of the ore into the battery becomes very apparent when we look at the figures of those mills which do not employ rock breakers, grizzlies and automatic feeding machines. With the absence of these appliances, designed to produce a regular supply of pieces of ore of uniform size we find an excessive wear of shoes and dies, and more particularly of the former, for the reason already mentioned. In five districts scattered over different countries and in which the rock breaker and feeder are not employed the wear of the shoe is never less than 10 oz. of iron per ton of ore crushed, while in the other three localities, where the mills are properly equipped, the wear never exceeds 7½ oz.

The successful use of wrought iron dies at some of the Australian mills is worthy of note. Experience indicates that the minimum of wear and tear is to be obtained not so much by the use of a metal of excessive hardness as by making the die of a material more tough and less brittle than that of the shoe. Thus, steel working on iron, chilled upon unchilled, cast upon wrought iron, etc., all give better results than when the metal of the shoe is the same as that of the die.

In the matter of screens there is often a practice of false economy. The relative cost of one kind of screen as compared with another can usually be disregarded by the mill man. In California the cost of the screens amounts to one cent per ton of ore crushed, and the mill man will do well to leave the expense out of the question and procure that variety of screen which best favors the particular conditions of discharge which he requires.

Table II. gives the wear of screens at different localities.

In Australia the old-fashioned round-punched Russia iron still holds its own, though it must manifestly do very imperfect sizing as compared to wire cloth. Thus, for example, the "grating" most commonly used at Bendigo has 143 round holes per square inch; these holes are 0.024 inch in diameter, so that the discharge area per square inch is only 0.064 square inch. A typical 30-mesh wire cloth screen, made in San Francisco, has openings of 0.025 inch square. Assuming for the purpose of comparison that the openings in the latter instance are the same as in the former, as is very nearly the case, we find that the discharge area of the wire cloth per square inch is 0.51, or eight times that of the punched iron sheet.

The screen, as used in many mills, can hardly be looked upon as a device for sizing the ore. The peculiar kind employed in Gilpin county has straight alternate burr slots which are 0.015 inch wide and ⅜ inch long. There are five slots in a length of two inches, so that there is afforded a discharge area equal to only 0.028 of each square inch. The chance of the exit of a particle of pulp is as 1 in 34. Some appreciation of this fact is shown by the local mill men, since it is their intention to use a screen which will retain the ore inside the mortar long after it has been crushed to a fineness permitting its passage through the openings.

In looking over the figures given in table it will have been noted that the life of the screens is subject to wide differences. This is due to a variety of causes. In Gilpin county, Colorado, for instance, the minimum is 16 and the maximum 80 days of service. When examining the mills of this locality I obtained the figures of five mills, and was much puzzled over the seemingly contradictory results exhibited. The explanation was found in the relative locations of the mills. They are all situated by the side of the creek which flows through Black Hawk, and beginning with the mill farthest up the creek, there is a steady diminution in the service of the screens, commencing with 80 days and decreasing to 16. The uppermost mill receives comparatively clean water, and after having used it returns it to the creek, together with the addition of a certain percentage of sulphuric acid, as sulphate of iron, derived from the contact of the water with the partially oxidized pyrites in the ore, under conditions favorable to a certain amount of solution. The water then passes on to the next mill, where its slightly increased acidity reduces the life of the screens from 80 to 73 days. This second mill in turn contributes its share of sulphates, which help to injure the screens of the third mill. At this point the very acid waters of one of the mines flow into the stream, and, moreover, before it reaches the fourth mill, the creek has washed the sides of banks of sand more or less charged with partially oxidized pyrites, so that when it at length reaches the two lower mills, the wear of the screens is measured by days instead of weeks. *

In a case of this kind the addition of quicklime is to be recommended. At Ballarat (Victoria) five pounds are added every twenty-four hours to each battery of five heads.

The effort to maintain a uniform depth of discharge is much to be commended, and the importance of such a uniformity is very generally overlooked. In addition to the devices mentioned by Mr. Olcott, I may instance the employment of blank strips of iron placed outside, and against the lower edge of the screen. These strips can be of various widths. When the discharge is thus heightened there will be a tendency to accumulate sand inside against the screen, and this will protect the screen from abrasion along its lower edge, where it is covered by the iron strips. I have seen this method used in New Zealand. Again, in Amador county, California, where the "chuck-block" is used, the uniformity of the depth of discharge is aimed at by the employment of chuck-blocks of various thickness. †

On the use of double discharge mortars, much has been said, but, in spite of frequent recommendation, they have gone out of favor. The main point to be considered in this connection is, that the use of a back discharge weakens the force of the issue through the front screen, and so gives results less than would be, at a first glance, expected. There is another objection, especially in dry regions, to the double discharge, namely, the consumption of water is considerably greater. This in itself proves the smaller force of the splash. At Clunes (Victoria), in the use of double discharge mortars, ‡ the consumption of water is from 8 to 10 gallons per stamp per minute, while at Ballarat, an adjoining mining district, with ordinary single discharge mortars, it is usually at the rate of 5 gallons. The crushing capacity is 2¾ tons per stamp in the former, and 2 tons in the latter case.

The minimum loss of quicksilver, which has come under my notice, was at the South Clunes United Mill at Clunes, where it was 5½ grains per ton of ore. The maximum was that of the Caledonia Mill at the Thames, New Zealand, where 1 ton of quicksilver was consumed in 2 weeks by 20 stamps.

Table III. indicates the loss at a number of localities.

In addition to the figures of cost of milling given by Mr. Olcott, I may contribute the data contained in Table IV.

† Continued discussion of the paper of Mr. T. A. Rickard, read at the Chicago meeting of the American Institute of Mining Engineers, August, 1893.

‡ This Table accompanied an article on this subject by the writer in the *Engineering and Mining Journal* of Sept. 23rd, 1893.

* See also "Variations in the Milling of Gold Ores," by the writer, in *Eng. and Min. Jour.*, N.Y., Sept. 3rd, 1892.

§ See a more lengthy desctiption in the *Eng. and Min. Jour.*, N.Y., Dec. 23rd and 30th, 1893.

‖ See *Eng. and Min. Jour.*, N.Y., Jan. 28th and Feb. 4th, 1893.

Table I—WEAR OF SHOES AND DIES IN STAMP MILLS.

Name of District.		Metal.	Weight. New.	Weight. Worn out.	Ore crushed during time of service.	Metal worn per ton of ore crushed.	Cost of metal per pound.	Value of the scrap.	Cost per ton of ore crushed.	Total cost per ton of ore crushed.	Remarks.
UNITED STATES:			Lbs.	Lbs.	Tons.	Oz.	Cents.	Cents.	Cents.	Cents.	
Gilpin County, Colo..	Shoes	Cast iron	83	27	80	11.2	4	1	3.82	5.95	No rock breaker; no automatic feeders; ore moderately soft; long drop; wear of dies is very variable.
	Dies	Same	48	26	78	4.5	4	1	2.13		
	Shoes	Chrome Steel	111	31	202	6.3	8	.	4.39	7.15	Rock breakers and feeders; ore very hard; dies contain ½ steel scrap.
	Dies	Same	55	25	159	3.0	8	..	2.76		
Grass Valley, Cal.....	Shoes	Chrome Steel	152	48	251	6.6	9	1½	5 17	9.43	
	Dies	Cast iron	93	45	96½	7.9	4½	1½	4.26		Rock breakers and feeders; ore soft; short drop.
Angels' Camp, Cal.. .	Shoes	Chrome Steel	175	40	585	3.6	9	..	2.70	4.06	
	Dies	Cast iron	95	35	275	3.5	4½	1½	1.36		Ore medium; rock breakers and feeders; no grizzlies.
Mammoth, Ariz.....	Shoes	Chrome Steel	132	40	190	7.7	11	..	7.64	13.14	
AUSTRALASIA:	Dies	Same	120	37	240	5.6	11	.	5.50		No rock breakers and no feeders; ore variable but medium hardness.
Bendigo, Victoria.....	Shoes	Cast iron	180	38	115	19.7	2½	¾	3.66	4.37	
	Dies	Wrought iron	98	26	335	3.4	2½	⅓	.71		No rock breakers; feeders used; ore almost entirely quartzose.
Clunes, Victoria.....	Shoes	Cast iron	196	56	105	21.3	2¾	¾	4.67	5.55	
	Dies	Wrought iron	138	30	420	4.1	2¾	⅓	.88		No rock breakers; feeders used; dies wear very irregularly.
Harrietville, Victoria..	Shoes	Fagot iron	172	38	185	11.5	3½	..	3.25	4.72	
	Dies	Same	84	37	200	3.7	3½	..	1.47		No rock breakers or feeders; ore of very variable hardness.
The Thames, N Zealand	Shoes	Cast iron	170	51	135½	14.1	3	1	3.40	5.65	
	Dies	Same	108	42	141	7.5	3	1	2.25		

Table II—WEAR OF SCREENS.

LOCALITY.	DESCRIPTION.	FINENESS.	Wear in Days.	Tons crush'd
Gilpin County, Colorado	Burr-slot Iron..	50 to 60 mesh.....	16 to 80	80 to 450
The Thames, New Zealand..	R'd-punched Russia Iron	148 to 180 holes per sq. in.	5 to 6	45 to 54
Clunes, Victoria.....	Perforated Copper Plate...	80 to 100 " "	25 to 30	312 to 375
Otago, New Zealand.....	R'd-punched Russia Iron..	140 to 180 " "	6 to 8	39 to 52
Ballarat, Victoria.	Same	120 to 200 " "	10 to 14	100 to 140
The Ovens, Victoria.....	Same	200 to 290 " "	17 to 20	145 to 175
Amador, California.....	Angle-slot iron..... / Steel and Brass Wire....	No. 7 & 8 or 35 & 40 mesh / 20 to 30 mesh	25 to 45	275 to 475
Grass Valley, California.	Tin Plate Round-punched..	30 mesh.....	16 to 24	140 to 220
Bendigo, Victoria.....	R'd-punched Russia Iron..	115 to 170 holes per sq. in.	9 to 17	95 to 180
Charters Towers, Queensland	Burr do Charcoal Iron..	200 to 225 " "	3 to 4	35 to 60
Treadwell, Alaska.	Angle-slot Iron.....	No. 7 & 8 or 35 & 40 mesh.	20	300

Table III—CONSUMPTION OF QUICKSILVER.

District.	Loss per ton of Ore. Minimum.	Maximum	Usual.	Remarks.
Gilpin County, Colorado	3.7 dwts.	9.8 dwts.	5 dwts.	Inside and outside plates.
The Thames, New Zealand..	12 dwts.	25 dwts.	14½ dwts.	Outside plates. Grinding in pans.
Clunes Victoria.....	5½ grains	5¾ grains	5½ grains	No plate amalgamation. Wells and barrel.
Otago, New Zealand.....	5 dwts.	8½ dwts.	7 dwts.	Outside plate amalgamation.
Ballarat, Victoria.....	2½ "	5¾ "	5½ "	Outside plates and wells.
The Ovens, Victoria	4 "	19 "	9 "	Outside plates. Grinding in pans.
Bendigo, Victoria.....	6½ "	9½ "	7 "	Outside plates and wells.
Charters Towers, Queensland	60 "	100 "	80 "	Outside plates. Grinding in series of pans.
Amador, California.....	2½ "	6½ "	4½ "	Inside and outside plates.
Grass Valley, California.....	11 "	15 "	12 "	Inside and outside plates.

Table IV—COST OF MILLING.

Mill.	Power.	Stamps	Cost.	Year.
Hidden Treasure, Gilpin, Colorado..	S. & Wt.	75	$0.78	1891
Gover, Amador, California	W.	20	0.53	1893
North Star, Grass Valley, California.	W.	40	0.81	'88-90
Wildman, Amador, California... .	W.	30	0.47	1891
Britannia, Ballarat, Victoria..	S.	40	0.56	1891
S. Clunes United, Clunes, Victoria..	S.	60	0.54	1890
New Chum, Con., Bendigo, Victoria	S.	30	0.58	1891
Excelsior, Charters Towers, Queensland	S.	50	1.95	1890
Saxon, Thames, New Zealand.....	W.	33	0.98	1892
Mountain, Thames, New Zealand...	W.	40	0.90	1892
Phœnix, Otago, New Zealand.....	Wf.	30	0.70	1890
*Morgan, South Wales, Gt. Britain.	Wf.	40	0.20	1891
†Phœnix, Wynaad, India...	Wf.	20	0.64	1884
†Mysore, Kolar, India	S.	90	3.05	1892
†May, Con., Johannesburg, S. Africa	S.	20	3.15	1890
†Jumpers, Johannesburg, S. Africa..	S.	100	2.40	1890
‡El Callao, Caratal, Venezuela	S.	60	1.08	1891
§Treadwell, Douglass I., Alaska....	Wf.	240	0.35	1893

NOTE: S—Steam. W—Water which is bought. Wf—Water which is free of cost.

*With steam power it was 52 cents, according to Dr. C. Le Neve Foster.

†These figures, which I owe to Mr. A. G. Charleton, are taken from his paper "The Choice of Coarse and Fine Crushing Machinery, etc."—*Transactions of Fed. Institute of Mining Engineers*, 1893.

‡Mr. Hamilton Smith, Jr.

§Company's report for half year ending November 30, 1893.

In each of the cases given in this table the cost of transportation is omitted. The cost of water power in California is usually about 20 cents per miner's inch (or 1.57 cubic feet per minute). At the Gover Mill this expense amounts to from 18 to 20 cents per ton of ore, while at the North Star it is 31 cents, so that, including the cost of power, the milling was done at these two thoroughly representative plants, at the rate of 33 and 50 cents per ton respectively. The ore crushed at the North Star is particularly hard. The use of grinding and amalgamating pans increases the cost at the mills of Charters Towers (Queensland) and the Thames (New Zealand). At the Phœnix (N.Z.) no plates, but blankets only, are employed.

The question of the turning of the stamp is referred to by Mr. Argall and Mr. Olcott. The amount of the revolution is dependent upon the height and speed of the drop, and upon the amount of grease upon the cam. Occasionally, when the cam surface has too much lubricant upon it, the tappet slips past without causing any observable turn. At four different mills, working under dissimilar conditions, I have noted the turn to be as follows:

	Stamp lbs.	Drop in.	Speed per min.	Amount of Turn.
Hidden Treasure, Gilpin Co., Col. .	550	17	31	1 to 1½ revols. per drop.
Garden Gully United, Bendigo, Vict.	780	9	80	1 revol. in 4 to 9 drops.
Harrietville, Ovens, Victoria	700	8	70	1 revol. in 4 to 7 drops.
North Star, Grass Valley, Cal	850	7	84	1 revol. in 5 to 6 drops.

As to the practical effect of the turn there is evidently much question. If the stamp turns as it is being lifted, it must continue to turn slightly after the cam has passed from under it. That the result, as far as it affects the ore upon the die, is insignificant in most cases, may be admitted; but it is supplemented by another factor, namely the inequalities of the surface of the shoe. The effect of the latter is various, sometimes causing the stamp to move bodily out of the vertical (a movement soon checked by the guides), and at other times causing a revolving motion. The die, of course, also wears unevenly, but as it is covered with ore, this fact has not the importance in this connection which must be allowed to that "cupping" of the shoe which promotes an irregular grinding action against the ore.

The use of a modern form of the arrastra at the Pestarena Mill, is quoted. The extraction, according to the report of the company, was 81 per cent. in 1888-89, and 78 per cent. in 1889-90. The loss of mercury in the respective years was 230 and 234 grammes per metric ton, equivalent to about 7½ pounds per short ton. The capacity of each mill was two-thirds of a ton per day. No doubt machines of the arrastra type will, in many cases, give the best conditions for promoting amalgamation; but, as compared with the stamp mill, most machines of the grinding class have a very small crushing capacity, and consume a great deal of mercury.

In commenting upon my description of the Gilpin county milling practice, Mr. Argall has made a series of verbal criticisms which seem to me unnecessarily hypercritical and occasionally unfair. I reply to them only so far as to make my meaning plain, using the numbers employed by Mr. Argall.

(1) He points out "that if the pyrites remained longer in the mortar than the other portions of the ore," certain results would follow. I ask him to refer to the paper which he is criticising, when he will find that he has no warrant for saddling me with any supposition such as that which he is needlessly controverting. I was emphasizing the fact that the main idea of the Gilpin county method is to retain the ore inside the battery longer than is necessary for pulverization, in order to give more opportunity for amalgamation. The ore is mainly pyritic, and it is the pyrite that is immediately associated with the gold, therefore I spoke of the pyrites remaining in the mortar longer than was necessary for crushing purposes, but not "longer than the other portions of the ore."

(2) My statement that "the long drop gives the interval of time required to allow the settling of the fine gald" is true. All the gold of the ordinary Gilpin county ore is fine, and because it is fine, the present system of reduction is employed. The character of the amalgam, and the low retort yield, are indicative of the minute sub-division of the gold particles. There was no comparison made or intended by me between the "coarse" and the "fine" gold in the ore, and Mr. Argall controverts his own imagination.

(3) It is quite possible to comprehend my statement without supposing the gold to be endowed with "the potentiality of locomotion." The deep discharge and the roomy mortar, both "jointly" and "severally afford a chance for the gold to get out of the way," because the depth of the one and the roominess of the other prevent the making of a violent splash, such as is produced in a narrow mortar with a shallow discharge; and the smaller force of the splash prevents a rapid exit of the pulp through the screen, and enables it to remain inside, so that the gold which it contains may be collected by the mercury lying at the bottom of the mortar, and by the amalgamated surface of the inside copper plates. If the discharge were shallow, and the mortar narrow, the gold could hardly get out of the way of the falling stamp without making its exit through the screen, and therefore, in the case of ore carrying gold in the finely divided condition which characterizes the Gilpin county mill stuff, it would not be possible to save more than a very small percentage inside the battery. It is indeed true that in California and Australia a good proportion of the gold is often arrested inside the mortar, but such gold is considerably coarser than that caught upon the amalgamated tables outside; and, moreover, the ore itself is of a different nature, and the gold is essentially less fine than that treated by the mills of Gilpin county.

Referring to the interval which occurs between the successive drops of the stamp and the pause which is thus occasioned, enabling the particles of gold to settle and become amalgamated, I remarked that "in a Colorado mill the interval is two seconds; in California it varies from three-fifths to two-thirds of a second." This was said in comparing the relative frequency of the agitation to which the water in the mortar is subjected by the action of the falling stamp. It is quite unnecessary to point out that there are five stamps in each battery, and that therefore the duration of the interval should be divided by five. If we carry out this line of reasoning we shall conclude that there is no time of absolute quiet, for when none of the five stamps of any particular battery are falling, the water is still being agitated by the concussion produced by the stamps falling in the mortar boxes on either side.

As regards the warming of the water in the mortar by the conversion of wasted energy into heat, I did not consider it very considerable; but, it may be, nevertheless, sufficient to add to the solubility of certain portions of the ore—as, for instance, partially oxidized pyrite. A careful test made at the Gover mill, Amador, California, gave the following results:—

TEST OF THE TEMPERATURE OF THE WATER BEFORE AND AFTER LEAVING THE BATTERIES, JANUARY 10, 1894.

	Before. Deg.	After. Deg.	Temp. of air.
8.30 a. m.....	37.0	40.0	40° F.
8.30 a. m.....	38.0	40.5	do
8.30 a. m.....	38.0	40.5	do
3.30 p.m.....	43.0	44.0	50° F.
3.30 p.m.....	43.0	45.0	do
3.30 p.m.....	43.5	44.5	do
3.30 p.m.....	43.0	45.0	do
4.30 p.m.....	42.0	44.0	48° F.
4.30 p.m.....	42.0	45.0	do
4.30 p.m.....	42 0	45.5	do

In his criticism of my statement that the retention of the pulp within the mortar, long after it is pulverized to a fineness permitting exit through the screen, has been used by the Gilpin county mill man to assist him in obtaining the conditions which he desires, Mr. Argall has missed the main principle, repeatedly emphasized by me, of the milling practice which he is discussing. The methods in vogue in Gilpin county originated in no idea of concentrating; if they had, then the excessive sliming of the pyrite, due to the deep discharge, would be a stupid blunder. On the contrary, however, the practice of the district is founded upon the principle of using the mortar, not only to crush the ore, but also, as far as possible, to make the mortar an amalgamating machine. The introduction of percussion tables for concentrating the pyrites in the tailings is comparatively recent. The mill man's intention is, to save as much gold as possible inside the battery, and, to do this by retaining the pyrite (with which the gold is mainly associated) inside, until a separation has been brought about; and these ideas are carried out by having a roomy mortar, a long, slow drop, and a deep discharge—more especially the last, which assists in procuring the condition he considers the most favorable to his purpose.

A statement was made, more than once, at the Chicago meeting, which does not, however, appear in the printed discussion, namely, that while the Californian type of stamp mill has been introduced in mining regions all over the world, that of Gilpin county has not passed outside its own *habitat*. This statement is not quite accurate, since mills of the Colorado type have been successfully used in Dakota, Montana, Arizona and Idaho; but, broadly speaking, it is no doubt correct to say that the Californian type is, by far, the more widely employed. Upon this fact is founded the suggestion that the methods of "the little kingdom" of Gilpin are not thought worthy of imitation. In commenting upon this matter, I trust I may be absolved from any charge of prejudice, since I have used both types of mills successfully, and have endeavored to discuss the advantages and disadvantages of both fairly. The explanation of the fact just referred to is somewhat as follows:—

The methods in vogue at Central City and Black Hawk were evolved under unusual conditions, and have been retained under peculiar circumstances. The first mills introduced, in the early "sixties," were modelled on the Californian type, and had a quick, short drop and a shallow discharge. While the mines were still in the gossan, or surface quartz, everything went well; but as soon as the unoxidized pyritic ores were reached the extraction began to diminish fast, and finally, this diminution nearly put a quietus to stamp milling. Then the smelter* came to the rescue, and prevented the cessation of mining during the years which elapsed until the mill men, by a long series of experiments, arrived at the conclusion that a long, slow drop, and a deep discharge, gave the conditions most favorable to the successful treatment of their ores. When the present methods were adopted, nearly twenty-five years ago, there was no market for low grade iron pyrites, and the ores, although containing from 10 to 25 per cent. of sulphides, would give up a large percentage of its gold contents when crushed in the deep mortars which had come into use as the result of a hard-bought experience. The old methods have been retained, but with the addition of percussion tables, because now the smelters charge very low rates of treatment for pyritic concentrates. Smelting charges are $4.50 for concentrates,* and $12 for crude ore. Railroad freight to-day (from Black Hawk to Denver) is $1.50 per ton on material worth less than $30 per ton, and $2 per ton for higher grade stuff. Small coal ("mine run") is delivered at the mills for $1.60 per ton. These are some of the conditions which have tended to perpetuate a milling practice which is, in many respects, out of date.

On the other hand, the methods of Gilpin county have not been adopted extensively elsewhere, because it is rarely that ores rich in pyrites are found to be comparatively so free milling. The Californian mill, moreover, in its typical form, is a crushing machine, adapted to preparing the ore cheaply and rapidly for a great variety of after treatment, by plate amalgamation, blanket saving, pan amalgamation, concentration, lixiviation, etc. It is, as a crushing machine, having its parts so arranged as to give a maximum of automatic handling of the ore, that the California mill is first of its kind. Compared with it, in this respect, the Gilpin county batteries are clumsy and incomplete; but, as an amalgamating contrivance for the treatment of a particular class of ore, they were well conceived at a time when amalgamation methods had no competitor in cheap smelting. Thus, after all, we do but return to the truism, which is often forgotten in these generalizations, that the milling practice to be introduced at any mine or in any district must be suited to local conditions, the most important of which is, of course, the character of the ore.

W. L. AUSTIN, (Denver, Colo.)—A word as to the current fable of which Dr. Raymond speaks. Stamp-stems being among the "working parts" of a mill are, therefore, included by Dr. Raymond in the category of the iron that does not crystallize. It will have been observed by any one who has operated a new stamp mill of the California type, with stamps dropping from 90 to 100 times per minute, that after his battery has been running 12 to 18 months, the stamp stems begin to break. Moreover, they break off, as a rule, right above the stamp head, though occasionally they snap off just under the tappet, and often it becomes a serious undertaking to remove the ends of the stems from these heads or "bosses." On account of these breakages, the stems are made tapering at both ends, so that when one end has broken off it can be reversed. In due course of time a similar mishap usually overtakes the other end. In many cases the mutilated stem is then laid aside as a problem for some future manager to solve, and new ones are ordered from the manufacturers. Now, the breakages may, as Dr. Raymond says, not be due to crystallization of the iron—for properly speaking, the iron, (which should be the best quality of wrought iron) originally used in their manufacture is crystallized, to begin with—but during the pounding which the stamp has been doing, some molecular change has taken place, changing the fibre into a structure coarsely granular in appearance. That such a change should take place is quite conceivable, for these stems are submitted to an unusual amount of jarring. The 3½ inch stem weighs 363 pounds, and the 3¼ inch stem 390 pounds, while the aggregate weight of stamp, including stem, head, shoe and tappet, is over 850 pounds. Such a weight, falling 6 inches 100 times a minute, for 300 days in the year, finds no parallel case in pump rods or the connecting rods of engines. As would be expected, when the shoe ir allowed to fall on the die, the life of the stem is shortened. The fact remains that the stamp stems do break, and the iron has the appearance of being what, in the absence of a better term, is technically known as "crystallized." There is a class of men engaged in milling throughout the West who have been brought up in mills and have made a business of running them. It is a common practice among these operators to take the stamp stems out of the batteries and anneal them by heating, and hammering them when the limit of safe working has been reached. These men are not chemists, and had once their little foibles, among which was the harmless use of sage tea and similar concoctions in their amalgamation departments; but they are first class, practical mechanics, and their experience and opinions in these branches of milling are entitled to respectful consideratiod. Among such men as these the fable spoken of by Dr. Raymond is still current. At one mill, which was under the writer's charge for a while, there was a man employed who was classified as mill blacksmith. He was the highest priced man carried on the pay-roll, and it was his special duty to repair the iron work about the mill, anneal stamp stems, etc. Considering the appliances at his command, he managed to perform what might be termed feats of blacksmithing, and among such was the piecing out and welding of 3⅛ inch stamp stems in an ordinary horse shoeing forge, so that they afterwards withstood the wear and tear of the battery. He always paid great attention to the careful annealing of such work; for it is the experience of mill men that stems thus treated last much longer than when such precaution is neglected. To have rendered this annealing necessary, the fibre of the iron must have undergone some change by the long continued jarring which the stems had received. One can easily satisfy one's self of the extent of this jar by taking hold of a stamp stem while in operation. It will be found to quiver violently If the molecular change which takes place among the particles of iron in a stamp stem after long and continuous use, by which the fibrous texture is altered into a granular one, may not be termed a crystal-

*The Boston and Colorado Smelting Co. commenced operations at Black Hawk in 1867. In later years the works were removed to Argo, near Denver.

* Or, "tailings," as they are termed locally.

lization, what is the proper expression to employ for such a phenomenon?

DR. RAYMOND.—Mr. Austin's remarks indicate a misconception on his part of the meaning of my statements concerning the alleged "chrystallization" of iron by vibration. It was not in the least my intention to quibble over a word. If I were so disposed, I should take exception to his present assertion that the wrought iron of which stamp stems are made is "crystallized," to begin with. The question in my mind, as I think a careful reading of my remarks will convince Mr. Austin, was, whether there is really a molecular change produced by vibration in wrought iron or steel. When Mr. Austin triumphantly inquires what is the proper expression, if "crystallization" is not, to describe such a molecular change, he simply begs the question. It will be time enough to discuss the name when the existence of the phenomenon has been demonstrated.

Before considering the evidence as to *that* question adduced by Mr. Austin, I would recall that my own criticism was made upon the sweeping statement of Mr Argall, that "vibration under all conditions will crystal *like iron.*" This I pronounced to be, "beyond question incorrect," and to this, my only unqualified assertion on the subject, Mr. Austin's argument does not apply. If his evidence proves anything, it proves only that iron is *sometimes* thus affected by vibration

As to this more limited proposition, I must frankly say that I see no conclusive force in Mr. Austin's argument The one fact upon which it rests is the breakage of stamp stems after twelve to eighteen months' running and the granular appearance of the fracture. But the fracture of a fresh bar of iron can be made to appear granular without any prolonged previous vibration, by the condition of the fracture itself. *A granular fracture does not prove an altered structure.* If the vibration theory wer correct, the rest of the stamp stem ought to be more or less altered in structure; and, indeed, other parts of the stem ought to be more affected than the parts where the breakages usually take pla ; for the two places mentioned by Mr. Austin, namely, "right above the stamp head" and "just under the tappet," are precisely the points of *minimum* vibration. They are the points of maximum *stress*, due to the checking of vibration by the stamp head or the tappet.

Now, it probably never occurred to Mr. Austin, or any of the practical mill men on whom he relies, to find out whether the parts of the stem which vibrate most freely are molecularly changed by such vibration; but some experiments of this kind which have been made have revealed no such alteration.

The fracture of iron under repeated stresses, no single one of which would produce visible rupture, is a very different proposition, and does not necessarily involve molecular change. It is more probably due to minute ruptures between the particles of the metal, which finally aggregate to constitute visible fracture.

I cannot admit that the vibrations in a stamp mill are more severe or more likely to produce molecular changes than those to which railway axles, marine shafts, and locomotive connecting rods are subjected. In these departments, quite as much as in stamp mills, the notion of "crystallization" by vibration is an old one, and the evidence in its favor is essentially that which Mr. Austin adduces, namely, *the granular appearance of fractures*, which, taken by itself, is quite inadequate.

If vibration produces molecular change, why should precious annealing prevent that change? As it would be manifestly impossible for Mr. Austin's mill blacksmith to anneal the whole of a stem in a horseshoeing forge, it *must* be that he annealed only the part which he had *welded*, which would be the very part out of which he had taken all effects of previous vibration. Such an annealing was very proper to remedy the unequal strains caused by the welding process itself, and to prevent the piece from breaking under stress or shock. But as it left untouched the rest of the "crystallized" stem, it can scarcely be considered as *regenerating* a fibrous structure. Moreover, a fibrous structure cannot possibly be produced by annealing.

In short, while I have never denied the possibility of molecular change in iron due to vibration, I must continue to regard the proposition as unproved, and the burden of proof as resting upon those who assert it, in the face of numerous experiments and careful tests which indicate the contrary. Mr. Howe's conclusion, after a patient analysis of much evidence, is:

> To sum up, while vibration and shock often cause rupture under light stress, and while it is proverbially difficult to prove a negative, we have, I think, every reason to believe that the granulation and crystallization of iron under vibration and shock is a myth.*

Unquestionably, the notion of a mysterious change produced by vibration in the quality of iron has worked double harm in stamp mill practice. On the one hand, it has been the convenient excuse of manufacturers, who declare the evidences of *bad workmanship* shown in fractures to be the result of subtle changes thus produced in originally sound pieces of good metal. On the other hand, mill engineers, believing that the inevitable vibration would break anyhow, in the course of a few months, the jarring parts of their mills, have given too little attention to the distribution of stresses and shocks by which such breakages might be greatly delayed or wholly prevented. If they would lay aside their preconceived notions, and disregarding even the opinion of the mill-blacksmith, study the mechanical reasons for the liability of a stamp stem to break just over the head or just under the tappet, I think they would find more significance in the way tappet and head are attached to the stem (so as to subject it to heavy side shocks at points where it is not made stronger than elsewhere) than in any amount of molecular speculation.

* *The Metallurgy of Steel*, p. 199.

Commercial Mining.*

By Mr. F. Danvers Power, F.G.S., M.A.I.M.E.

(From the Mining Journal, page 95.)

The width of a vein is another important point. The cost of nearly all mining requisites is greater in proportion for narrow than wide veins, with the exception of timber A man is cramped when working in a narrow place, and cannot put the same force into his actions as if he had more room. There are more re-entering angles in proportion to the are of the face when working in narrow than in wider levels, and therefore the miner is hampered in the judicious placement of his drill holes, and the effect of his blasting material is not so great as it would otherwise be. A miner naturally does not desire to extract more country than necessary, simply for the sake of enlarging his working place, or he may find a quantity of mullock left on his hands over and above that which he can utilise for packing purposes, which he has to go to the expense of sending to the surface. Even when given the length, direction, underlie, and with of a vein we have not all the knowledge we desire about it. Veins, as a rule, are not of the same value throughout, the greater portion is barren or nearly so; the rest is classified according to its nature into firsts, seconds, etc. The ore-bearing portions are termed "shoots," and the impo tance of a vein greatly depends on the dimensions and quality of these "shoots." We want to know the ratio of the ore to the gangue, and how much dead work must be debited to each ton of ore extracted; also whether the ore is rich enough to bear the expense. The way in which the ore is distributed in its matrix, the nature and quantity of the associated minerals, and whether they are deleterious to the metal sought, must also be considered, for if disseminated through the vein stuff it may have to undergo the expense of being "dressed" before it is ready for the market.

Many expensive mistakes have been made by men who, only thinking of the metal to be extracted, have quietly ignored the presence of undesirable substances till it was forced upon them, as in the case of a certain iron ore in Tasmania. Mere traces of some impurities so impare the value of a metal as to decide whether a mine is to be placed on the list of paying or non-paying ventures. Such technical details can only be learnt by study and experience, for there is no royal road to this end. The rule-of-thumb man may manage to scrape along in simple cases, but as soon as a real difficulty arises he is utterly helpless, so has to fall back on his better informed neighbour for assistance. Shoots sometimes occur in the form of pipes, when they are called "pipe veins," and they extend for some distance more or less vertically. A shaft sunk on such a shoot would show ore all around. People before now have too hastily jumped to the conclusion that the vein between two shafts sunk on such cylindrical shoots was as rich as the ore they saw exposed to view, but later on have had reason to regret the loss of the money with which they backed up their opinions, supported in all probability by the crude judgment of some illiterate miner, instead of seeking the mature advice of a professional man.

The presence of much water in a mine in districts where surface water is scarce, or easily lost by evaporation, may be the salvation of a company. On the contrary, an excess of water that cannot be utilised, may prove its ruin. Working expenses are often greatly increased by the presence of objectionable gases in a mine, by the occurrence of swelling floors that must be cut down constantly, or by the nature of the rock, which, when hard, adds to the labour of mining, or if bulky, danger to life is added to the expense of careful timbering; while if a stratum of quicksand is encountered, all previous work may have to be abandoned while necessary arrangements are being made to dam it back. Occasionally, owing to the bad selection of a site, or due to mining operations themselves, the works are subject to "creeps" or landslips. I once remember seeing men working at a brown coal deposit in Australia in a most dangerous position, there being a huge slice of the hill above, ready on the slightest provocation to overwhelm them; in order to temporise, the manager had connected the slipping portion and the main hill with a rope attached to trees growing on the respective parts.

Certain minerals that depend on their size, colour, transparency and such like qualities for their market value must be prospected on a large scale to determine what output may be expected. Mica, for instance, is used for various purposes, depending on such qualities: the large sheets of white, transparent, flawless mica fetching the highest price, it is naturally the object of miners to avoid breaking up suitable pieces more than possible; yet in dressing it for the market there it much waste. A hundred pounds weight of block mica will scarcely yield more than about 15 pounds of cut mica, and sometimes even less. The scrap, it is true, can be sold for minor purposes, but its value greatly diminishes with its size. When working a mine in the proximity of old excavations plans of such old workings should be secured when possible, for tradition is not to be relied upon, and is apt to become distorted by time. The possession of such plans may save a mint of money in advance work, in avoiding the unwatering of old workings, or the payment of compensation for death or injury to the workmen in case of accident. Shareholders have a voice in choosing the directors who actually carry on the business of a company, for very little work would be transacted if all the shareholders met to deliberate over every small detail. Directors are frequently elected before an individual, who is late in joining a company, becomes interested in the mine, but it rests entirely with that individual whether he throws in his lot with the others or not, and if he cannot assist in selecting the shareholders' representatives for that term of office, he at least has the opportunity of approving of their *personnel*. On looking over the names of directors certain persons are dazzled by the handles attached to some, and feel flattered at the opportunity of being associated with them. Others, again, acknowledging their ignorance in *mining matters, trust to the wisdom they assume the* directors to be possessed of, instead of using their own common sense, which would stand them in better stead. They conclude that the mine must be good, otherwise so-and-so would not have gone into it, and in case of difficulties, no doubt his influence would bring them out safely.

If a business man has purchased a large interest in a mining property, it is only natural to conclude that he has carefully enquired into the matter, and if satisfied with its prospects; also that his large interest is sufficient to warrant him in accepting a seat on the board so as to assist in supervising the business of the company for his own profit; and in attending to his own affairs he, if honest, also promotes the interests of his associates. Unfortunately, however, directors are not always such as is sketched above; there are some who sell their names with the usual accompaniments without the slightest intention of performing the duties that are expected from them; they are simply figure-heads, and their names are used as decoys for those who do not think for themselves, but take statements for granted on the strength of another's name. One can hardly expect a man who is given shares in a company for the sake of his name, to have the same lively interest in its welfare as a man who has invested his hard earned savings in it. We cannot pretend to know the true reasons that influence a director to take certain steps, and unless one is behind the scenes, it is difficult to judge of the motives of the guiding hand. He may take advantage of early news received officially from the mine to instruct his agents to buy or sell as the case may be before the rest of the shareholders are given an opportunity, forgetting that he is representing others as well as himself; or he may be a professional guinea-pig, who attends as many meetings as possible in the day so as to qualify for his fee, caring little or nothing how he scamps through his work, so long as the formality is got *through*. We cannot condemn too much those men who accept fees with no intention of fulfilling the duties their position requires of them, and which their friends and the public, who joined on the strength of their personality naturally expect. It is not desired by any means to run down professional directors as long as they do not belong to so many companies that they are unable to pay proper attention to their business. On the contrary, there are many advantages in obtaining the services of the right sort of professional director, for they can give new companies the benefit of their experiences gained elsewhere, and their knowledge is handed on to others who are *graduating for professional directors themselves*. A laborer is worthy of his hire, whether he works with his head or hands, so it is only fair that a director should be paid for his trouble, besides which, it acts as an incentive to close application to the interests of his company.

The ideas that emanate from the brains of some directors are as annoying to the harassed mine manager as they are absurd; for example, the English directors of a South African mine, in reply to their manager, who wrote to say that a new shaft was necessary, which he estimated would cost £500, said they thought the price was exorbitant, and enquired if he could not buy a second-hand one at a less figure! Or, again, a Victorian mine manager, after well testing a reef, wrote to his directors informing them that the mine was a duffer, the reef being only three inches wide, containing hardly any gold, so he recommended them to close the mine, and divide what balance was left among the shareholders. Well, one director, who had also been a vendor, was very vexed, and plainly said he suspected the manager of wishing to depreciate the property, so that he could secure it cheaply for himself, and offered to visit the mine to see how matters stood. On his return the director reported that things were just as he expected, that the reef was looking well, and was 6 feet 6 inches wide, the whole length of the tunnel. The manager was naturally asked for an explanation, which was to the effect that what he had previously stated was quite true; that the director had arrived with the intention of teaching him his business, which he commenced to do by measuring the depth of the reef exposed to view in the face of the drive, which he had mistaken for its width, which still remained three inches of "buck quartz." Similar absurd mistakes were made in the early days of Victorian reefing, when men, hearing that gold was found in quartz, thought it it referred to a measure, and so started for the goldfields with buckets and pans, being under the impression that *they could pick up the precious metal like periwinkles on* the seashore.

Some directors are as bad as old women at auction rooms, as far as buying up all sorts of unnecessary and useless machinery is concerned, which they send on to the mines. I remember once having the misfortune of being employed by a company whose directorate was given that way, and I do not desire a similar experience; they,

moreover, were under the impression that they understood more about the technicalities of the work than their manager and it was only by accident if the original orders were attended to. If double tape fuse was ordered they would send up single because it was cheaper, and they considered the former extravagant; the time lost over misfires did not count for money with these directors. Did you desire powder or dynamite, you would receive some new fangled explosive for an experiment, the range of which you would have to find out, accompanied with the usual difficulties one has in getting an ordinary miner to adopt something he is unaccustomed to. There is a certain mineral property I have in my mind's eye where the managing director, formerly a wholesale butcher, and the mine manager, who was by trade a fitter, put their heads together over a second hand volume of "Phillip's Elements of Metallurgy," from the study of which they decided to erect a furnace for treating copper ore that was originally designed for smelting iron. In due course the plant was finished and the furnace put in blast, but unfortunately the mine manager, a very worthy and hard working man, had never seen any smelting done, so it was hardly surprising when before twenty-four hours had passed the furnace was choked up, the crucible was chilled, and all the heat was at the mouth of the furnace. Of the little matte and slag that was tapped, the former was thrown over the tip—now carefully covered up—while the slag was bagged for shipment home. So long as people have such a confusion of ideas that they cannot distinguish between an engine driver or fitter and an engineer, or between an apothecary or druggist and a chemist, we will continue to have the wrong people in the wrong places.

One man I know in Melbourne makes a point of owning the largest share in any mining venture he goes into, so that he can have the controlling voice in its future. By this means he has an interest which is worth his while to look after, and he can command the money of his fellow shareholders to carry out his plans. Most of the mines are managed in his office, and should one fail and go into liquidation, he sells the machinery to one of the more successful mines, whether it wants it or not as long as it suits his plans, which it generally does, for he mostly has a mortgage over the defunct property.

As to the constitution of a company, that also frequently determines its success or otherwise. If a limited liability the property is at least sure of a fair trial, provided the capital subscribed is sufficient and is used for the working of the mine; but if a company is registered under the No Liability Act, like most of the Australian mines, it is convenient for a shareholder who wishes to back out by forfeiting his shares, should he not be satisfied with his prospects; but the difficulty of securing calls greatly retards the development of a non-dividend paying concern, and tempts the legal manager so to manipulate the mine manager's weekly reports as to give them a false color. Many an unhappy mine manager, surprised at seeing a report supposed to proceed from him, writes to town to demand an explanation, in reply to which he is informed that his report was too long to print *in extenso* so it had to be curtailed; that it was written in such bad English the legal manager was obliged to put it into readable form; that the use of technical expressions made it necessary to simplify the report for the public use; or, in some cases, instead of trying to cover their actions by excuses, the mine manager is told straight out that it would be impossible to get calls in with such a report as he wrote, and that many more like that would close the mine and throw him out of employment.

A mine is like a child—it must have money spent on its development before it can be expected to pay its way, unless it is a monstrosity. There are many mines, which, if opened up properly to commence with, would pay well, but as they are worked on a small scale, and exist on a hand-to-mouth principle, they cannot make ends meet. It is generally cheaper to work on a large than a small scale; the expenses of management is distributed over a larger number of men; miners, instead of being suspended when work is slack at one part of the property, which breeds discontent, can be employed on another portion, and so, instead of creating dissatisfaction among the employees, you gradually collect and retain the best skilled labor in the country, which always comes where constant employment is certain; in short, on a large property, the different departments can play into each other's hands, and it will pay them to do things for themselves that a small mine would not be warranted in doing, owing to the expense of the first outlay in a plant that could not be fully utilized.

There are, of course, many properties that Nature never intended should be converted into mines, but in spite of which man insists on working, in the hopes of extracting valuable metals, if not from the rock, at least from the shareholder's pockets. Again, there are other properties, which, although they cannot pay at present, owing to adverse local conditions or the want of improved processes, will yet pay at a later date when these difficulties are overcome. But there are other mines that ought to pay now, if properly worked, which on account of the bad way in which they have been financed bring no profit except to the first robbers. Under this category are those mineral properties that have proved failures when under capitalized, but which, when reconstructed on a more liberal scale, have been successful; in the meanwhile much money has been thrown away, and the original shareholders require a large profit to make up their losses. The number of shares in a company, their value, whether they are fully or partly paid up, whether ordinary or preferential, and whether they have all been subscribed for, are all important features in the success of mining from a monetary point of view. It may be easier at times to float a mine in £1 shares than if valued at, say, £100; they both have their *pro et con*. A low-priced share enables it to circulate among a class of people whose presence is not always desirable; they may take a fancy to operate on the shares, and to bull or bear them in such a manner as to finally ruin the reputation of the mine; this is not so readily done in more expensive parcels. The mine manager can at times checkmate such persons, or at least can make it more difficult for them to practice their nefarious plans. If his mine is properly opened up, he can equalize the values of his output by treating rich ores, when circumstances prevent him from working large quantities, such as want of water or fuel; he thus diminishes the excuse for sending shares up or down in the market with every fluctuation of the weather.

If vendors are partly recouped in paid-up shares, they should not be allowed to flood the market with them to the hurt of those shareholders who have paid hard cash for their interests. Sometimes, in order to entice the public to take up shares, the vendors guarantee a certain interest for so many years; this interest, when not forthcoming from the property, is sometimes paid out of the cash received for the mine, or from the sale of shares received in part payment; in other cases they "bear" the shares down to such a pitch that they are enabled to purchase the majority of the shares at a less price than they guaranteed for interest, and then close the mine. The fact of a mine having paid dividends is no proof that it is a desirable one to invest in; the dividends may have been procured by the sale of "paps," or even direct from the capital in the hopes of drawing fresh blood into the concern; or dividends may be paid out of money fairly earned, which would have been better to place in a reserve fund, so as to avoid the necessity of a call for, say, increasing the plant; in such a case the dividend is virtually paid out of the call. Other causes which result in disappointment to mining investors might be mentioned, such as the excessive prices often given for properties, mere prospects, on which interest can only be expected in years to come, if ever. Miscalculations as to expenses of working are rife, the cost of stoping frequently being taken as the total cost of mining, no allowance being made for deadwork, depreciation of plant, contingencies, and the hundred and one other expenses, all of which give their quota to the cost of winning a ton of ore.

The public seem rather to like the process of being taken in; at least they lend themselves to it very kindly; it is so nice to be the favored man, to be allowed to go into a good thing through the unselfishness of a vendor, who offers you a chance in preference to anyone else, notwithstanding that you are an utter stranger to him; it is also pleasant to be considered an authority on mining matters with no trouble to oneself. In the meanwhile, perhaps, the bubble bursts. In the hope of getting out at the top market prices, the disposal of shares was put off till too late, and an adequate interest on the inflated value of shares, or even a return of the money spent, is a thing devoutly to be wished, but hardly likely to be realized. One point to be remembered is that a fair interest on the original nominal value of shares may dwindle down considerably when applied to the quoted market rate, if high.

That there is a good deal in a name is recognized by certain vendors who give their mines the modified names of some well known property, either in the hopes that the public will confuse the names and buy the wrong stock, or intending that the public shall assume that the new mine is as good as the more noted one; but any mining man knows that a district is not to be measured by the richness of one mine, and that when one property is proved successful, dozens of others spring up around it, both on and off the line of lode; thus we find a mine, which is afraid to stand on its own bottom, is called the so-and-so north, south, extended, etc.

Since a great deal depends on appearances, it is sometimes considered advisable to spend more than the fair share of money on surface works that are readily seen, at the expense of productive undergreund work; in fact, in such a hurry are some companies to make a show that they erect works before there is any stone to treat, or before they are acquainted with the necessary process suitable for the extraction of the metal. Much money is thus thrown away on worthless or unnecessary machinery, and when this is added to that lost in absurd prospecting, excessive payments to vendors, law suits, and numerous other leakages, it is little wonder that we hear the oft-repeated statement that it costs more than £1 sterling to get a sovereign's worth of gold. If mining is to be saddled with all the mistakes and fads of those who put their money into such ventures, the remark must be accepted as true. The price of shares are at times so low, due to blunders, that the value of the plant is more than the market value of the mine and its accessories.

"The ore is refractory" is an expression often made use of to shield ignorance. The term refractory is an arbitrary one. What is refractory to one man is not to another. Give a metallurgist money and he will extract the metal from any ore; it is true that the extraction may not be an economical success, though it may be a technical one; local conditions too frequently step in, and make it advisable to employ a less thorough process, which leaves a fairly high percentage of ore in the waste, because the extraction of the last portion will cost more than its market value. It might be as well here to utter a warning against those inventors of processes or machines that claim to win a certain percentage of the metal in the ore. In making a fair comparison of percentages, the ores treated should contain the same amount of metal; it is obviously a bad or unsuitable process that only wins 80 or 90 per cent. from 100 oz. auriferous quartz, but the same percentage from a 5 dwt. parcel would be considered very good. In many new countries ores are sent to Europe for treatment. Were it simply the knowledge of treatment that is required, it would be cheaper to import men with the necessary training; but, may be, want of fuel is a drawback, skilled labor may be expensive and uncertain, barren fluxes may have to be used instead of making one ore flux another, for in a new country prevailing conditions are seldom such that ores from different parts of the world can be brought together and suitably blended. Then it may be most economical to concentrate by a raw smelting and to send the product to be refined at home, because the colonial market may not be large enough to utilise the bye products and pure metals, and when precious metals have to be sent away for consumption it is cheaper and less risky to ship silver locked up in "pigs" of lead than it is to send the silver bars separate.

The few hints given in this article touch but a little of the points that should be considered by persons about to invest in mines, and will help to show that there is much more in mining transactions and operations than the ordinary dabbler appears to be aware of. If a man will not take the trouble to make due inquiry into his business, he must not be surprised if he is unsuccessful. There is no effect without a cause, and it is only right that one should master the causes that are likely to influence his investments. The natural value of a mineral deposit cannot be affected by the artificial market transactions of man, but the amount of money put into or taken out of our pockets, which chiefly concerns us, can be greatly influenced by his manipulations. The opinions of oversanguine men, however well intentioned they may be, must be accepted with caution; we must not base our calculations on abnormal conditions, but take a fair average and make due allowance for bad times; in fact we must conduct our transactions in connection with mines on the same lines as we would our ordinary avocations, for to enter upon indiscriminate speculation is to court ruin and disaster, which is bound to come sooner or later to those who tempt Providence.

The Commercial Aspect of Coal Mining.

(Excerpted from Mr. G. A. Mitchell's Presidential Address to the Mining Institute of Scotland.)

As a coal master I am inclined to look first of all at the commercial aspect of coal mining. The great question is: How are we to make our mines successful? Sometimes we hear of an interesting modification of some piece of machinery, ingenious and involving a new principle. We may admire it, but we ask ourselves—not, will it work—but is it a real improvement, is it an economy? In the same way the ultimate question to be asked in connection with all changes in mining is: Are they profitable, the question of safety to life, of course, always coming first? I intend to speak, therefore, as a coal master on some subjects which affect the successful working of collieries.

To make the most of a colliery we must (1) sell the produce to the best advantage; and (2) work at the lowest possible cost.

In speaking of the first of these points, I will refer to the practical side of the question, viz.,

THE SUITABLE PREPARATION OF THE COAL FOR MARKET,

and what has been done, in a general way, with regard to this during recent years. What I can say on the subject must be more or less familiar to you all.

Not many years ago it was thought that no preparation of coal was required, and little attention was paid to the handling and cleaning. It was screened over ordinary bar screens, possibly too short and too steep to be very efficient, and any foreign matter present was allowed to find its way, with a good deal of dross, into the waggon. If the coal was sold for household purposes a little extra care was taken, but, if it was for shipment or locomotive use, the quicker it could be passed over the screen the better. That coal sold as well as it did was due to the fact that the seams which were being worked were mostly clean and of good quality. Coal was abundant in the country, and any seams of inferior quality or with ribs of stone were generally neglected altogether. As coal became more scarce, however, attention had to be paid to seams formerly left untouched, and, to obtain a satisfactory market for the coal from such seams, it was found necessary to devise some means of removing the foreign material and of sorting the different qualities. Various forms of picking tables and screening arrangements were introduced, and there are few collieries now where such tables are not to be found in operation. As picking became common it was found that, even for good seams, increased care in screening, handling, and sorting improved the value in the market, and, even for such seams, picking tables and jigging screens are now largely used. Few seams are of uniform quality throughout. In most there is a mixture of hard and soft coal, each suitable for a different purpose. For instance, we may have a hard coal which is good for furnace purposes, and which burns with a light, white ash and along with it a soft coal which is suitable for house use, and which burns with a dark colored, heavy ash. If the two are filled together the coal is neither first class as a furnace coal nor satisfactory as a household coal, but, by proper separation, good prices may be got for both kinds. Or, again, part

of a seam may be inferior, and the mixture of even a small proportion of the inferior part may reduce the value of the whole.

But it is not only in the case of round coal that attention must be paid to the handling of our products. It is almost of more importance to prepare the dross for the market so that it may be sold to the best advantage, and it is barely necessary for me to remind you that dross is an import part of the output of every colliery. Although miners' leaders seem to ignore it altogether when they speak of prices realized, the coal master can never forget it, for in many collieries it forms more than fifty per cent. of the total output, and the proportion tends to increase as the depths of the pits become greater. When we look back over the last twelve or fifteen years we must be struck by the extraordinary change that has taken place in the value of dross. We all remember the time when it was of very little value. I have sold dross at 6d. per ton at the pit, and was glad to get rid of it at that price. Now, a good dross sells for nearly as much as an inferior coal, and the difference between the price of coal and dross at certain times is comparatively small. This is due to various causes, but I think I put it fairly when I say, that it is very largely due to the increased consumption and sale of dross, made possible by the improvement in the quality due to washing and careful sizing.

The desire for economy in fuel consumption has for many years caused steam users and manufacturers to turn their attention more and more to dross, but it has only been in recent years, since abundant supplies of clean dross could be got, that the great impetus has been given to the substitution of its use for that of round coal and triping.

But it is not only in the home markets that dross is now an important item, but in the export trade also. It has been found that clean dross is of value although very small in size, and that, by sub division into different sizes, various markets may be suited. What was formerly sold as dross merely is now, when washing is carried on, divided into from three to five different sizes, and a very large trade has been developed, specially for the larger size of nuts, for export purposes.

It is not many years since there were only three or four washing machines in Scotland. Now there are dozens. Fifteen years ago I do not suppose the shipments of nuts would amount to 30,000 tons per annum. Now the exports are hundreds of thousands of tons. It has been abundantly shown that a good article will make new markets for itself.

There is another direction in which something has been done to increase the value of small coal. I refer to briquette making. This is comparatively a new industry for Scotland, but there are now several extensive plants in operation. I believe that there is room for greater development in this direction. Where washing machinery is in operation, and where there is sufficient quantity of the smallest size of washed material of good quality, the making of briquettes should be exceedingly profitable. The difficulty hitherto has been to keep the plants going during the summer, but if briquettes can be made cheap enough, it should be quite possible to form for them a satisfactory shipping connection.

Washing has had special attention, and I don't know if any other Institute in the country has gone so thoroughly both into the theory and the general arrangement of machinery for the purpose. There is still room for more papers on these subjects, as there have been many improvements during recent years in the different arrangements. There are better washers and better plants generally now than there were when the Coal Cleaning Committee's report was presented in 1889.

The surface erections at a modern colliery are of a very elaborate description, and more and more care is being taken to make the arrangements such that the output can be satisfactorily handled with the minimum amount of labor. At some collieries, where modern machinery has been erected, it is safe to say that the coal is being cleaned and satisfactorily prepared for the market, at quite as low a cost as it formerly took to put it into waggons without any cleaning whatever.

We cannot say that we have come to an end of the improvements that are possible, and there is still room for inventive ingenuity in designing tippers, screens, picking tables, methods of lowering coal into waggons, etc. I believe that twenty years hence we shall consider antiquated what are now the most improved modern arrangements.

I cannot but refer here to the lamentable absence of one link in the chain of improvements. The railway companies are still making use of the barbarous methods of shipping coal common many years ago. It is little short of a disgrace that coals, carefully loaded in good condition at the collieries, into railway waggons, should be treated with such scant consideration at the shipping ports. It is evident to any one who has watched the shipment, for instance in Glasgow, that much of the care spent in handling the coal at the collieries is rendered of no effect by the smashing which it gets in falling from the trucks into the holds of the vessels.

When the railway companies and harbor proprietors shall have given us the best possible arrangements for shipping our coal, we shall feel that we are neglecting nothing that can assist us in placing our coal and dross in the market, in the condition most favorable for commanding the best price that can be got.

WORKING COST—THE LABOUR QUESTION.

The preparation of coal for the market is of immense importance, but, after all, the main question we have to deal with is the working cost. In speaking of the necessity of working at the lowest possible cost, I feel that I must refer, first of all, to that question which has been so specially exercising the minds of colliery owners during the past year. I mean the labour question. In ordinary circumstances I should avoid the subject altogether, as something largely beyond the control of colliery owners and managers. Until recent years wages fluctuated with the demand for coal, and high wages ruled when trade was good, and good prices were being realized, and the wages were low when trade in general was bad. During the past year or two, however, we have been brought face to face with a different state of matters. The prices of coal have varied so much from artificial causes depending on labour troubles, that it has become increasingly difficult to conduct business on the accustomed lines. The labour question has become so serious that I feel that, instead of avoiding the subject, I should require rather to make an apology if I did not refer to it at this time, when I speak of the cost of working.

Of late years trades' unions have become very powerful in all branches of trade, and have shown themselves strong enough in many cases to cause the most serious stoppages of business. It is not for me, here, to discuss the advantages or disadvantages of trades' unions; no doubt working men have as much right to look after their own interests as the employers have to guard their own. But it is certain that unless these unions are conducted with prudence and wisdom, their powers may be exercised in such a way as to seriously injure the business of the country. Unreasonable demands made by a strong union may be successfully enforced for a time, but the concession cannot bring any lasting advantage to those employed.

You will remember that during the whole of the year 1893, trade all over the world was in a seriously depressed condition. In sympathy with the general depression the coal trade suffered. The demand gradually abated, and prices fell rapidly. Following on this, in most districts, wages were reduced, but in the Midland districts of England the Federation of Miners' unions was so strong, and it was made so plain by the Unions that any reduction of wages would be resisted that, to avoid a strike, the intimation of a change in wages was postponed as long as possible. An attempt was made to keep up the prices, but it might as well have been attempted to stem the tide, and contracts, when they fell out in the summer, had to be renewed at large reductions in price. It was found necessary to intimate a reduction of wages at the end of July. The miners resisted, and the disastrous strike which continued full sixteen weeks was begun, and lasted until Lord Rosebery intervened.

But what was the demand on the part of the men? Why was a reduction resisted in these districts when already enforced elsewhere? It was acknowledged that prices had been lowered. It was well known that the miners were earning a daily wage far in excess of that ruling in other districts, and, nevertheless, any reduction of wages was strenuously resisted. A new cry was raised—the demand was for a minimum daily wage of about 7s. per day. It was contended that the miner is entitled to a good living wage, and that this should be made a first charge on the cost of production. This is a logical demand. It is, at first sight, even apparently a reasonable demand, but, if it is properly considered, it will be found to be economically unsound, and I am satisfied that it can be shown to be a claim which, if established, would have a most serious effect on the coal trade and other industries of the country, and, which, moreover, would not be for the benefit of the miners themselves.

With reduced exports of coal, reduced consumption owing to reduced exports of manufactured goods, and increased imports from other countries, it is to be feared that it would be found that a minimum daily wage would be a very different thing from a living wage. Miners would be better with full work at 4s. or 5s. per day in times of depression than with 7s. per day with work for only two or three days per week.

The other alternative, of course, would be that a large number of miners would lose employment, but such a state of matters the Miners' Federation refuses to contemplate. It is certain that, even without increased costs, we shall gradually lose many of our foreign markets, but the process may be a gradual one and may go along with the exhaustion of the coal fields in a natural way. If costs are suddenly raised the decline in shipments will be more rapid, and the hardship to miners through many being thrown out of employment will be very great.

It is not sufficiently realized that we are able to pay higher wages and give our working men in this country a better standard of living very largely on account of cheap fuel, and that, if fuel rises much in price, wages must come down to enable us to compete in foreign markets. It would be a curious anomaly if a high minimum wage were fixed in the coal trade, and that the direct result was a lowering of the earnings of all other classes of labour.

No coal master grudges good wages where they can be paid, and history shows plainly enough that there are times when very high wages are earned, if there are other times when the figure is below what all would desire to see. The average is above that earned by men of the same standing in other industries, and it is surely not much to ask those employed in the coal trade to take the good with the bad, to make the most of good times, and to help the country during periods of depression by taking lower wages to cheapen the cost of fuel, and so stimulate demand and prepare for better times. It is to be hoped that this claim for a minimum wage will be very seriously considered before being further pressed by all the men interested and that the leaders will not force on demands which will, in all probability, only end in disaster for the miners themselves, and in ruin for many colliery owners and manufacturers.

The leaders sometimes speak as if the easiest way to pay extra wages would be simply to reduce profits, but such statements are thoughtlessly made. It has been estimated that the coal trade of this country has returned on an average little more than 3 per cent. on the outlay, and it is not easy to see where advanced wages could be paid out of profits were the return even twice this amount.

I have spoken at too great length on this question, but the problem is a serious one, and I feel that every one interested in mining ought to have a clear apprehension of the commercial importance of the claims that are now being made.

It may be that some ultimate good will come out of the disputes. Trade differences may, after all, have their useful purposes to serve. As Shakespeare says—

> There's a divinity that shapes our ends,
> Rough-hew them how we will.

All these contentions may be the crude way that men have of putting wrong right. No doubt reasonable counsels will prevail, and ultimate harm to trade may not be done. It is to be hoped that our country will continue to prosper in the future as it has done in the past.

The prosperity during the past century has been beyond all anticipations. We are told that James Watt, the inventor of the steam engine, said, when he left Scotland, that he was glad to go, because the climate was bad and the trade of the country was done. He may have been right in the former statement, but I wonder what he would say about the latter if he could pay a visit now to our collieries, our steelworks, our engineering shops, and our ship-building yards.

But, though we may have confidence in the future, it is nevertheless our duty to consider, with the utmost care, what can be done to avoid disputes and enable work to be smoothly carried on, when we have to face such demands as those we have been considering, and when we have too much reason to fear trade disputes, even if the demand for a minimum wage is dropped entirely.

Various expedients have been suggested for settling disputes. Conciliation boards have been advocated are in existence in some districts, as notably for the Midland district, where such a board is on trial for a year. I believe that a conciliation board can never be very satisfactory except possibly if confined to dealing with the large question of general advances and reductions of wages. Such boards should never have the power of interfering between any individual manager or master and his men. It is impossible for any outsider, by a casual visit, to gauge accurately the working rate for any particular place or set of places in a colliery where circumstances vary so much. The adjustment of such rates must, in fairness, be left to arrangement between manager and men and to the natural competition between man and man.

There is, to my mind, more hope for sliding scales. No doubt, many of you will have read, with interest, a series of articles on this important subject, by Dr. Smart, which have been published in pamphlet form. Dr. Smart has taken a great deal of trouble in getting up all the statistics on the subject and he has put very fairly and clearly what is meant by a sliding scale. There are, of course, difficulties in connexion with the working of sliding scales, owing to the varying conditions under which coal is worked, but I believe that even if the sliding scale be not economically sound, yet as an expedient for adjusting general advances and reductions of wages, it is well worth trial. The difficulties can be overcome if the subject is approached in a fair-minded manner by masters and men.

It seems to me that the principal points to be observed for a fair sliding scale are: (1) it should be such as to give as nearly as possible the same wages as those that would rule without a scale, viz., there should be large percentages of advances and reductions of wages with the rise and fall of prices; (2) it should act quickly and frequently; and (3) it should be open for revisal at stated periods. The subject is too large a one for me to take up here at length, but I mention it now, as I look upon the sliding scale as one of the best expedients for preventing dislocations of trade such as have recently occurred.

I think we may take it for granted that, even if wise councils prevail and the miners' leaders learn to take a reasonable view of the wages question, we have come to a time when wages will be generally at a higher level than formerly, with rises and reductions taking place periodically, but with rises to higher levels, and with reductions not to such a low level as formerly. In view of this, and of increased competition, it is very necessary for mining engineers to relax no effort to introduce all possible improvements in working, that coal may be raised at the lowest possible cost. This is all the more necessary from the gradual increasing difficulties in mining.

There are many seams now being worked which would not have been touched twelve or fifteen years ago, either on account of their great depth from the surface, thinness or inferior quality, or the heavy quantity of water to be pumped. The increase in the depth of working seams over a series of years has been very noticeable. In a recent paper, Prof. Hull gives the average increase in depth for England, since the introduction of steam engines, as being at the rate of 13½ feet per annum.

I could give many examples of thin and inferior seams now being worked which were formerly neglected, but it is hardly necessary to do so as you are all aware of the fact. There are many collieries which were supposed to

be exhausted twelve or fifteen years ago, which are producing a fair output still, mainly from seams such as I speak of, and there are districts which seemed to be approaching exhaustion many years ago, which have lately shown signs of new life.

IMPROVEMENTS IN MECHANICAL APPLIANCES.

Fortunately mining engineering has kept pace with the increasing difficulties to be met, and there are many improvements in the various departments which have assisted in keeping down costs. If wages are to be higher in the future, there will be more occasion even than in the past for the introduction of labour-saving machinery, and managers should be on the outlook for every possible plan of introducing it.

In my opinion there is a considerable cheapening of cost to be looked out for by the adoption of coal-cutting machines. There are, no doubt, many seams which are unsuitable for their use, but they might be adopted with success in very many cases. One of the things that has prevented their more general adoption in the past is the heavy first cost with the fear of failure, indeed with the history of failure in many cases. Another difficulty has been that compressed air, the power generally employed, while convenient in many ways, has the disadvantage that the efficiency is very low, and the trouble in laying pipes and in connexion with their upkeep is very great. I believe that, at no distant date, electricity will solve these difficulties. Wires are very much more easily laid than pipes, and an efficiency of fully 50 per cent. can be got, against 20 or 25 per cent. for compressed air.

There are many other advantages and comparatively few drawbacks. The advantage to be gained from coal-cutting by machinery is not only reduced cost at the face, but concentration of output, and therefore reduced on-cost charges. With machines, very much more coal can be put out from the same faces than with men, and, therefore, haulages can be conveniently arranged to work closer to the faces, and these haulages will be worked more economically because they will have a larger quantity of material to convey. This aspect of the haulage question is important. In many cases the cost of bringing coal from the face to the rope is a large proportion of the total cost of drawing. The system used at the Bent colliery, and described in the *Transactions*, appears to be one of the best designed haulages in this respect. The rope can be brought very near a range of working-faces, and the hutches can be hung on more easily than with most haulages, at a number of different places. I think a similar arrangement might be adopted with advantage in longwall as well as in stoop-and-room workings, provided the coal field has a moderate and fairly uniform dip and rise. One great advantage of the system is that single roads only are needed, and this is a very important point for longwall workings where the roof is bad.

It is well adapted where it is desired to have a self-acting haulage from rise workings. There are some haulages on this principle at the Hallside colliery which appear to be very successful. It is a pity to see the forces of nature going to waste, and there are many cases where the force of gravity and power to be got from falling water might be employed for useful purposes.

One of the subjects in connexion with haulage which deserves very special attention is the conveyance of power from the surface to the workings by ropes, steam or electricity. We require papers for the Institute on this subject, giving actual results from experience—not mere general statements, which are of little value.

The arrangements for loading and unloading cages at pit bottoms and on the surface are of great importance, and perhaps often too little considered.

There are a very few examples of some of the points requiring careful attention, but every detail in connexion with the working of a colliery is of importance. To have pulleys, haulage-rollers, hitches, etc., all of the best construction, and kept in the best condition, is of great moment, and we would be surprised, I am sure, if we were to know the actual loss in money occasioned by the want of attention to what are often considered trifles. Take for example the question of balance ropes for cages in deep pits. Mr. C. M. Percy has shown the result, by calculation, of working with and without a balance rope. He takes a pit 1,200 feet in depth with an output of 1,000 tons in 8 hours. He makes out that in such a case the use of balance ropes would save three Lancashire boilers 25 feet long and 7 feet in diameter. These are striking figures, as an example of the importance of what appears to be a detail.

COLLIERY FUEL CONSUMPTION.

Perhaps one thing that is as much deserving of attention as anything about a colliery is one which has been least considered in the past, and that is the fuel consumption. As small coal becomes more valuable, this question is pressing itself more and more upon the attention of those interested in the working of collieries. The importance of it to the nation as well as to colliery owners is evident, when we consider that at least 9,000,000 tons of coal are used annually at collieries, and the quantity becomes greater in proportion as the shafts become deeper, as the water in many cases becomes heavier, and as there is a more extensive use of machinery for haulage and other purposes. New collieries show considerable advance in attention to fuel economy. Improved boilers are superseding those of the egg-ended type. Boiler pressures up to 100 lbs. per square inch are becoming common. Compound condensing engines are being extensively used for heavy pumping purposes. Expansion-valves are more often made use of. Feed-water heaters are almost universal. Stokers and improved fire-bars are frequently introduced, and steam-dryers and traps are common. It is a pity that we have not more statistics to guide us in the actual saving effected by the adoption of such improvements. It would be an exceedingly interesting thing, for instance, to take a colliery where little attention is paid to fuel consumption, to take indicator diagrams from all the engines, find their defects, and put them into good order, to adopt various improvements, such as heaters and steam traps, and then find the saving of fuel resulting.

When we consider all the various points that are of importance in connexion with the working of a colliery we must be struck by the amount of varied knowledge that colliery managers require to be possessed of. There has been in the past, perhaps, some tendency to elevate practice at the expense of theory. The latter ought—to a considerable extent—to regulate the former, and one great objection to rule-of-thumb management is that every colliery manager very largely learns for himself, and, to some extent at least, must acquire his knowledge at the expense of the colliery which he has under his care. As the poet Coleridge said, "Human experience, like the stern lights of a ship at sea, illumines only the path which we have passed over." But it ought to be our aim to let our experience benefit others as well as ourselves, and to prevent the loss of knowledge gained thereby. This can be done by endeavouring to reduce practice to theory, and by forming general principles which may guide others. Do not think, however, that I am speaking against the value of practical knowledge in any way. Theory may help practice, but it can never take its place.

As a writer has put it—"When we use another's light we must not take his candlestick, nor even his candle, except to kindle our own at it." The education which a man gives to himself is always more valuable than that which is given to him, and the best part of our knowledge is that which we work out for ourselves, but it is, nevertheless, true that the stored-up knowledge of others will often save us much unnecessary labour.

I have a strong feeling that mining engineering has not been developed like other sciences in such a way as to give a record of the results of investigations made. The books on the subject are, for the most part, far too general in their nature. In each new one published it is sought to cover the whole ground, and it therefore often is no real addition to the literature of the subject. The time has surely come when the science should be more specialized, when we should have separate books dealing with various forms of working, haulages, coal-cutting machinery, washing machines, and cleaning plant, etc., all giving careful descriptions, going into details, and taking up theoretical as well as practical questions.

In connexion with the importance of working from general principles I may call attention to the great need of accuracy, and the great advantage of taking careful notes for every colliery. All managers who work on this principle must feel what an immense advantage it is to have carefully recorded all the information about the workings of a colliery. Take for example the careful levelling of a coal-field. If it is troubled, and if there are, in consequence, mires to cut, much expense will often be saved by the knowledge of levels in different parts of the coal field, and where these are known in one seam, the workings in other seams can be laid out to greater advantage.

Where a seam is exhausted, and another has to be worked in the same coal field, it is often felt what an immense advantage it would be to have such details available, and most mining men are familiar with puzzling over old plans to make the most of the meagre information which they give.

So far as I have referred to colliery managers, colliery owners, and engineers, but it is not to these only that we should look for improvements in mining. Valuable inventions, especially in details, might be made by intelligent workmen if they were encouraged to devise improvements in connexion with their work. It is the man who is constantly engaged with particular details who is most ready to see defects and most ready to suggest improvements, and not the coal master, engineer or manager, who have all to attend more particularly to the larger and more important matters in connexion with the management.

MINING LAWS OF ONTARIO.

ANY person may explore Crown Lands for minerals. Mining lands may be taken up as surveyed locations or staked claims.

Locations range from 40 to 320 acres.

Claims range from 10 to 20 acres on vein or lode.

Locations may be acquired in fee or under leasehold.

Price of locations north of French River, $2 to $3 per acre, and south of it, $2 to $1.50, according to distance from railway.

Rent of locations first year 60c. to $1 per acre, and subsequent years 15c. to 25c. per acre.

Rent of claims, $1 per acre each year.

Claims must be worked continuously.

Royalty on ores specified in the Act, 2 per cent. of value at pit's mouth less cost of labor and explosives.

Royalty not charged until seven years from date of patent or lease, nor (as provided in s. 4 (3) of the Mines' Act, 1892), until fifteen years in the case of an original discovery of ore or mineral.

Original discoverer of ore or mineral on claim entitled to stake out a second claim.

Crown Lands sold under provisions of mining laws in force prior to 4th May, 1891, exempt from royalty.

Copies of the Mines Act, 1892, Amendment Act, 1894, may be had on application to

ARCHIBALD BLUE,
Director Bureau of Mines.

TORONTO, May 25th, 1894.

PROVINCE OF NOVA SCOTIA.

Leases for Mines of Gold, Silver, Coal, Iron, Copper, Lead, Tin

—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.