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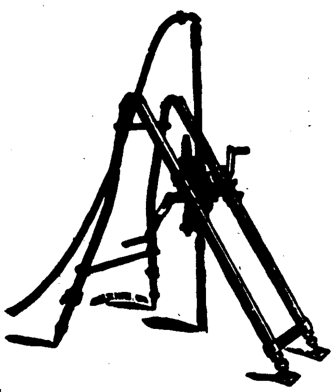

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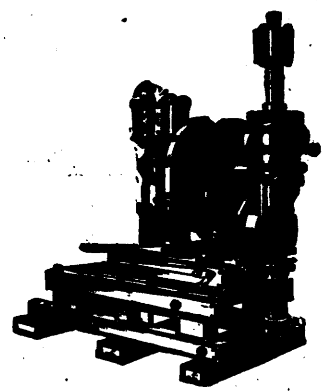

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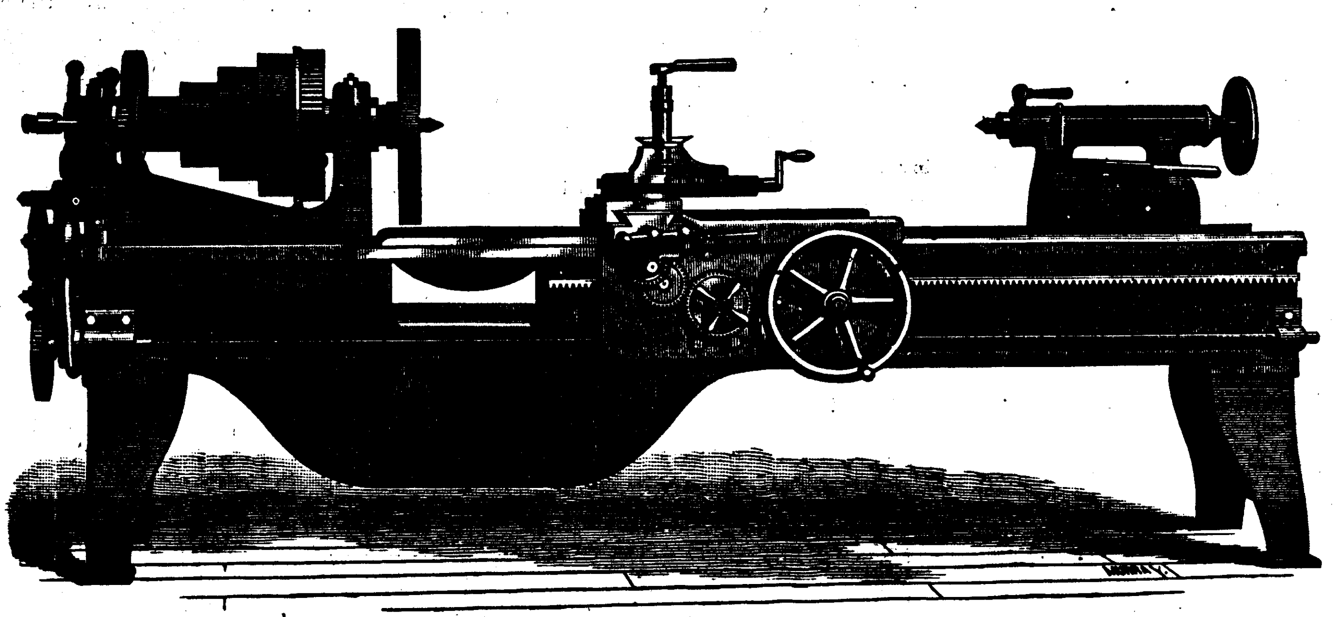

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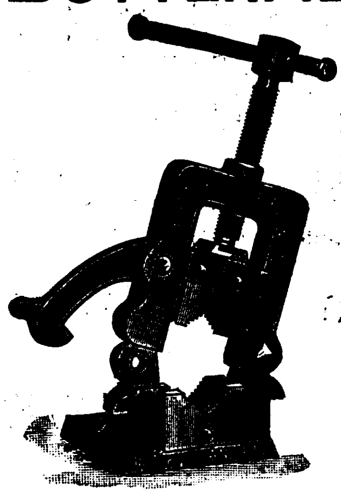

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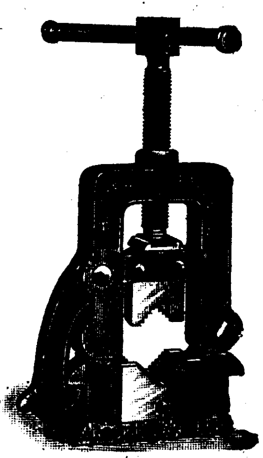

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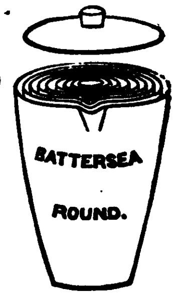

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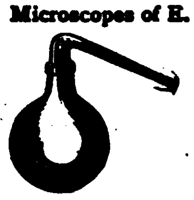

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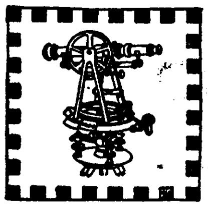

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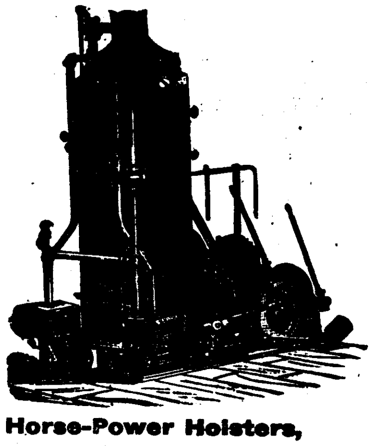

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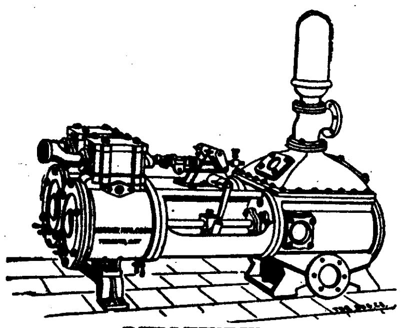

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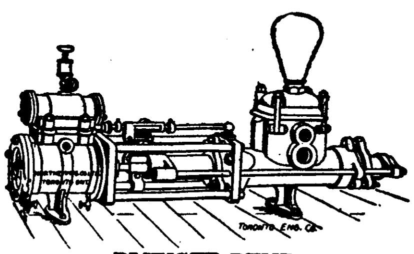

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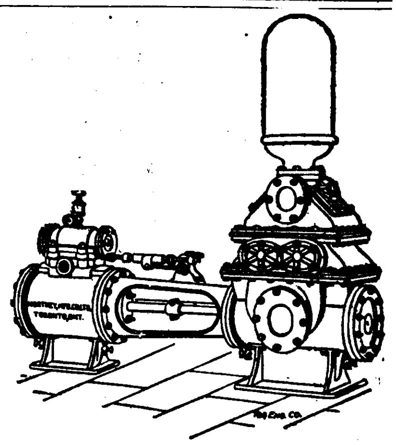

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CANADIAN MINING & MECHANICAL REVIEW

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

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Vol. XIII. JANUARY, 1894. No. 1

Mining Machinery.

From an article in a recent number of the *Canadian Manufacturer* it would appear that manufacturers of mining machinery want to destroy the industry which is their sole market, flattering themselves that they can derive support like the fabled sloth from the suction of their own paws.

The present wail of these spoilt and petted manufacturers is that mining machinery of a class or kind not manufactured in Canada has been and may be imported free of duty according to an Act passed by a Government which they must acknowledge is distinctly protective in its policy.

The Act in question was passed in order to give some measure of protection to the promising industry of mining—not protection from the honest tonic of competition, which is the life and soul of progress in trade, but protection from the short-sighted greed of one class of manufacturers who ask their fostering government to legislate for them only, and compel another and much more important native industry to use antiquated, illadapted machinery at exhorbitant prices merely because it is manufactured here.

There are none so blind to facts as those whose vision is obscured by self-interest, and it would appear that this particular class has been so pampered and spoilt that it cannot recognize the equal rights of another native industry and does not look upon mining, which brings more foreign capital into the country, employs more labor, and results more than any other in general prosperity to the fortunate district in which it is located, as a Canadian industry at all.

And this great industry, this robust, masterful son of a new country, which asks for so little, is to be denied its equal rights, is to be handicapped forsooth that one of its feeble, rickety brethren, represented by the manufacturer of one pump, one stone breaker, or one rock drill may flourish without effort and without the wholesome spur of competition, which they evidently need, to bring them up to the level of merit of the high class manufacturers of other countries where mining machinery is manufactured up to date to meet the ever changing requirements of a progressive industry.

Countries where miners do not make shift to use a Blake-Marsden crusher when a pulveriser is what they want, or a Northey pump for a deep coal pit instead of the specially designed colliery pumps like that of the Jeansville Iron Company of Pennsylvania, which they may consider will suit their purpose better.

Is the mining industry to be denied the right of its own judgment and free choice, in favor of a specially protected industry? If so the whole trade system of the Dominion is a farce and in the abstract goes far to show the inherent economic weakness of a protective policy, the bolstering up of one class at the expense of another, as long as the latter will submit to it.

Our miners are not to use the machinery they think most economical and most suitable to their requirements; they must be taught that it

Mr. John Blue, Eustis Mining Co., Capelton, President General Mining Association of Quebec, 1894.

is advisable for them to use only one or two kinds, it is expedient and proper that they be denied selection from the inventive genius and workmanship of the world, in order that one or two Canadian manufacturers may exist on the secured profits of a few protected machines. One can imagine to what an absurd extent this system might reach if unopposed.

An experienced miner coming to a new country after being accustomed to the modern mining machinery of more advanced countries, in stating his wants to the local manufacturer would be told: "My dear sir, your past experience is a mistake, you don't know what you want here, a Clarkson-Stanfield concentrator may be all very well in its way but we don't make it, it is a new-fangled, modern idea unsuited to this country where protection makes it inexpedient and unnecessary to make many changes and impovements, what you want is a good old-fashioned Rand drill or a Northey pump, or a good substantial steam hoist; they may be rather expensive articles because the import duty imposed to protect us from the pernicious influence of modern thought and the improvements of the rest of the mining world, makes it more expensive to manufacture them here, and we really are too busy reaping easy profits to be bothered with a first-class machine like the one you ask for; we can of course make you a separator if you must have one because we are engineers and can therefore make all kinds of machinery as we have taken care to point out to the Department of Customs. It will take some time to do this, however, as we have not given much special attention to separators and it will be costly and may not be quite successful at first, therefore do you not think you had better take something else instead?"

Seriously, let us look at the matter in a matter of fact light and see if according to their own statement the manufacturers have anything to complain of.

Miners in Canada find it more convenient to buy machinery made here if it is what they want, because it can be inspected before purchase and manufacturers cannot complain of want of custom hitherto. What the miners, however, claim as their right is that they shall have that class or kind of machinery which they want, and which is not manufactured in this country, duty free.

As to any technical difficulty in determining the "class or kind" manufacturers have certainly nothing to grumble about.

It is well known that the General Mining Association of Quebec has since its formation always encouraged the membership of manufacturers, and it cannot be denied that they are already well represented and have had a powerful voice in its deliberations on all subjects.

At the quarterly meeting held in Montreal on the 7th April, 1893—Capt. Adams presiding—when the importation of mining machinery was thoroughly discussed, there were present many representatives of the mining machinery industry noticeably, Mr. F. A. Halsey, of the Canadian Rand Drill Co., Sherbrooke; Mr. John M. Jenckes, Jenckes Machine Co., Sherbrooke: Mr. Gillman, of the Ingersoll Rock Drill Co., Montreal; and others. It was moved by Mr. B. T. A. Bell, secretary of the Association, and seconded by Mr. John Penhale:

"That a special committee representing the mineral operators of the province, consisting of Mr. John Blue, Mr. J. Burley Smith, Mr. Geo. R. Smith, Mr. S. P. Franchot, and himself, with *an equal number of gentlemen representing the manufacturing interests of mining machinery in Canada*, be appointed to frame a statement of mining machinery not manufactured in Canada, and that the said statement be submitted to the various Canadian Mining Associations for approval, before being finally submitted to the Department for official reference."

This joint committee of machinery manufacturers and mineral operators met at Sherbrooke on the 12th May, 1893. There were present: F. A. Halsey, J. M. Jenckes, J. S. Mitchell,

J. Burley Smith, L. A. Klein, John Blue, F. P. Buck, B. T. A. Bell, B. Rising.

"After discussion, the secretary submitted an elaborate statement, showing the various classes and kinds of machinery known to be made in Canada, together with those which were known not to be made and which were being imported. *He stated that a circular had been addressed to every machinery manufacturer in the Dominion*, asking them to furnish particulars of their manufactures, and that an invitation had been sent to each to send representatives to this meeting. The information given in response to these circulars had been embodied in the statement which he thought was fairly complete. Messrs. Halsey and Jenckes, mining machinery manufacturers of Sherbrooke, made objection to furnishing the department with any statement showing machinery that was not manufactured, claiming that a statement of what was made would serve the purpose equally well. After discussion this was agreed to. The committee then proceeded to discuss the statement of machinery made, which, after some alteration was adopted, and the secretary was authorized to forward it to the Mining Society of Nova Scotia for its endorsation prior to the meeting of the Association on July 5th, 1893."

Now the writer in the *Canadian Manufacturer* complains—"that such list has been prepared, and has been submitted to the Government, and that it has been drawn up entirely in the interest of users of mining machinery with a view to making the construction of the law which has hitherto been quite general, absolutely so

This is most unreasonable as it is shown by the foregoing that the manufacturers on the appointed committee repudiated the list of machinery not manufactured, and substituted that of machinery manufactured in Canada, and the accepted list is the one which they preferred and agreed to in committee, and indicates clearly that the manufacturers do not want to meet the miners in the same liberal spirit shown by the latter, and that they would tax all the mining machinery if they could, and that, unrestrained, their short-sighted cupidity would do its best to destroy the industry by which they live.

No reasonable man would deny the usefulness of a Rand drill, a Northey pump, or the acknowledged excellence of the Ingersoll-Sergeant coal cutting machine, but all these have their limit of utility, and if miners consider some other kinds and makes are an improvement, are more modern, or have advantages not possessed by those made in Canada and are practically necessary to enable them to compete with the mines of other countries, and they are not made here, then they have an undoubted right to import them free of duty according to the recent Act of the Dominion Government, which desires to foster all her industries and not one particular class only.

Gypsum Production in Nova Scotia during the year 1893.

This industry appears to have kept in the even tenor of its way, and there is little to note beyond the depression due to the dullness of the principal market, the United States.

The output to the close of the year is, so far as information can be obtained at the time of writing, in round numbers 160,000 tons. This does not include about 5,000 tons used locally for house work and for fertilizers. The export is principally to the United States. The district having a practical monopoly of the export trade is that of Windsor. A few miles from the town on tide water is a large quarry controlled by the Messrs. Dimock, of Windsor. This quarry is connected by a railway with the wharf, and is very favorably situated for working. Other smaller quarries are found at Walton, Cheverie, Newport, Hantsport, etc, in this vicinity.

During the past season a small quarry has been opened at Parrsboro', on the Bay of Fundy and a few hundred tons shipped to the States.

There is a mill near Truro which supplies a considerable local trade in fertilisers.

In Pictou and Antigonish counties a very limited amount is used locally. Passing to Cape Breton the quarry at Lennox Passage returns about 6,000 tons shipped, it is stated, principally to New York.

The Victoria Gypsum Company near Baddeck mine a very superior grade of plaster. Their shipments are in the vicinity of 20,000 tons. Small lots were shipped from Port Hood. At Mabou quite extensive operations have been carried on by the Mabou Gypsum and Coal Company. The returns for the first nine months of 1893, show shipments of 11,700 tons of plaster, and of 27,000 bags of fertilizer. Good shipping wharves have been built here and it is anticipated that there is a good opening for the purpose of manufacturing gypsum fertilizers.

As is well known the quantity of gypsum in Nova Scotia is simply inexhaustible. The finer and whiter qualities are abundant, and preferred for shipping. The other soft varieties are equally good for agricultural purposes and are more commonly met with. It is surprising that the beneficial qualities of gypsum as a vehicle both for manufactured fertilizers, as well as for constant use in stables, etc., for compost is not more widely recognized. Its capabilities for retaining liquid and volatile constituents of manures are unsurpassed, and it is in itself directly beneficial to many soils. In France these uses are well understood and acted on. The production of gypsum in England is limited and is stated to be decreasing annually. The prices there per ton are such as might under favorable conditions of freight permit of shipments from Cape Breton.

The Iron Industry of Nova Scotia, 1893.

During the past season the business of this industry has been advancing steadily and surely. At Londonderry work was continued as usual. Explorations in the immense territory controlled by this company have shown extensions of the ore deposits, calculated to ensure ore supplies for some time to come. The Torbrook ore has continued to give satisfaction. There has also been the usual amount of spathic ore calcined, and the Brookfield limestone quarry has been worked for flux.

Late in the fall the Pictou Charcoal Iron Company resumed work, having secured the additional capital required to fairly launch their enterprise. There is no doubt that the brand of this company will soon have a well recognized value, as their appliances and material are calculated for the production of a first-class charcoal pig. The prospecting work of this company has resulted in the location of a valuable deposit of brown hematite on the head waters of Sutherland's River, in a locality not generally considered likely to contain this ore.

The New Glasgow Iron, Coal and Railway Company may now be said to be in good running order. The difficulties inherent in starting a blast furnace in a new district appear to have been overcome. The question of fuel, ore, flux, mixtures, etc., appear to have been solved, and for some time past the furnace has been running on pig for the New Glasgow Steel Works, and it is proposed to also give considerable time to the production of foundry pig. It is anticipated that there will be ample employment for the furnace. It is specially pleasing to learn that the supplies for the steel works can be procured locally. The mines and railway of the company are now completed and in good working order. The company's railway runs from Hopewell to Sunny Brae, a distance of 12 miles. It is to be hoped that no distant day will see the extension of this road some 35 miles to Sheet Harbor, on the Atlantic coast. This admirable haven open all winter would afford a ready and short outlet for Pictou coal, iron ore, etc.

Some exploration work was done on the Bartlett and Holmes areas, in Pictou County, and the results have been confirmatory of the high opinion expressed by Sir William Dawson and others of the deposits of specular, limonite, etc., covered by these properties.

At Arisaig, Antigonish County, explorations carried on during the past few years have shown that there are numerous bodies of iron ore well adapted for mining, from their size and accessibility. A few hundred tons were mined by the New Glasgow Iron, Coal and Railway Company and tested at their Ferrona furnace, and found to be quite satisfactory.

This district is close to shipping and railway, and will be an important iron ore producer in the future.

At Torbrook, Annapolis County, the only mining operations are these of the Torbrook Iron Company. Here the regular production has been continued and the mine has been placed in effective condition. The vein continues about six feet in width, of uniform quality and free from faults. Some explorations in the district lying south and south-west of Torbrook show that the extent of territory underlaid by iron ore is much larger than has hitherto been believed to be the case. As this locality is near shipping facilities, and well provided with railways it should benefit by any change in the United States tariff, placing iron ore on the free list. The following figures will show the amount of iron ore raised, and the pig made in Nova Scotia during 1893 :—

	Tons.
Iron ore raised.	89,000
Pig iron made	41,000

The Montagu Mine Disaster.

The sad accident at Montagu Mines, near Halifax, N.S., which is mentioned in our Mining Notes, and whereby four miners lost their lives, is worthy of more than passing comment.

The direct cause of the disaster was undoubtedly a lack of correct information as to the extent of the old underground workings. The property came into the hands of the Symon-Kaye syndicate, a London corporation managed by Mr. Alfred Woodhouse, in the summer of 1892. At that time, and for some time previous, the property had been idle, and neither plans nor information were on fyle or accessible as to the extent or character of previous workings. We believe we are correct in saying that Mr. L. J. Boyd had made a map for the promoters' use which purported to show these workings, but as they were filled with water this map evidently could only have been based on hearsay, and therefore was quite unsuitable as a guide for future workings.

Shortly after obtaining possession the local management started to sink a new shaft about 190 feet west of an old one, called the Cooper shaft (our figures are from the evidence given at the Coroner's inquest), and ultimately a depth of something over 100 feet was reached.

Some four months ago good quartz was struck in this shaft, and since then work has been pushed more vigorously. Levels running east and west, at a depth of one hundred feet, were driven, and a back stope started from the roof of the east level. It was in this stope, as we understand, that the best quartz was to be seen, and the stope was carried up to a height of over 30 feet from the level at the time of the accident. It was in this stope also that the fatal shot was fired at 8 a.m. on the morning of Dec. 28th. From Boyd's plan it would appear that over 60 feet of solid rock intervened between the stope and the old workings carried west from the Cooper shaft; as a matter of fact there could not have been over 3 feet, as the hole fired was only 18 inches deep, breaking both ways and flooding the new workings to a height of 28 feet in three minutes time.

The question at once arises who—if any one —was responsible for the accident? and were proper precautions taken?

While it has been said in some of the Halifax papers that there is no provision in the Nova Scotia statutes for the fyling of correct underground plans of gold mines, we think differently. Sections 19 and 22, and sub-section 9 of Section 25, Chapter VIII., cover this accident *with this exception*, that Sections 19 and 22 are applicable only in case twelve persons or more "*have ordinarily been employed below ground*," but Section 25 has no limitation as to number of employees, and is therefore applicable.

That part of Sections 29 and 22 which applies is as follows:—

Sec. 19. When any mine is abandoned, the owner of such mine at the time of such abandonment shall, within three months after such abandonment, send to the office of the Commissioner an accurate plan on a scale of not less than two chains to one inch, showing the boundaries of the workings of such mine up to the time of the abandonment.

Sec. 22. The owner, agent or manager of every mine of coal, &c., &c., shall keep in the office at the mine an accurate plan of the workings of such mine, * * also the owner, agent or manager of *all other mines* in which more than twelve persons are ordinarily employed below ground, * * on or before the 1st day of April of each year, shall furnish to the Inspector a correct plan or tracing of the workings up to the 1st day of January then last past.

The question that first arises, therefore, is whether the owner or owners at the time the Cooper shaft workings were made, "ordinarily employed twelve men below ground"—if they did, by the sections above quoted, they are responsible, if they did not, then these sections cannot apply, but the Commissioner should see to it that they are amended so as to apply in future to all cases.

It is obviously impossible and unfair to expect of the Inspector (who in his dual capacity of Deputy Commissioner and Inspector is probably the hardest worked man in the Government's service), that he should look after all the small workings going on intermittently here and there, and procure and place on fyle maps of all such workings. These maps should be made by the lessees, and on them should fall the responsibility of neglecting to furnish them, as is the case with coal lessees.

But when we come to sub-section 9 of Section 25 we have no limitations, it is one of the "General Rules" which are to be observed in every mine. The Section reads as follows:—

(9.) Where a place is likely to contain a dangerous accumulation of water the working approaching such place shall not exceed eight feet in width or height, and there sha'l be constantly kept at a sufficient distance, not being less than five yards in advance, *at least one bore hole* near the centre of the working, and sufficient flank bore holes on each side.

From the evidence given at the inquest it was shown by the foreman (Savage), that water had been coming in heavier than usual for a week before the accident, and that on the morning of the accident it was running in faster than usual, and that 24 hours previous a hole that was fired shifted the course of the water from the foot wall seam to the hole.

From the published accounts in the Halifax papers, it is evident that some of the workmen were afraid of the danger impending, and that more than one miner quit work because of apprehension of the mine being flooded.

Under these circumstances it would certainly appear that there was knowledge of "a dangerous accumulation of water," and as the manager, Mr. Woodhouse, had been in this country "two years and three months," he should have known of this statute and have given orders for the necessary bore hole to have been carried in all faces working towards the old ground.

We do not hesitate to say that good mining practice, without the statute referred to, would always keep a long bore hole ahead in approaching ground that was known to be worked out full of water.

We are reminded also by the Halifax *Herald* that Mr. Woodhouse came to Nova Scotia with quite a flourish as to his previous experience and great ability. While we do not say that Mr. Woodhouse's neglect was directly or indirectly the cause of this disaster, we do say that the course he pursued was not that which an experienced or capable mining engineer would have followed.

The lesson of the disaster, not alone for Nova Scotia, but for all the other Provinces of the Dominion, is to look to their statutes regulating mining, and see to it that there is embodied there regulations making the periodical correction of all maps of underground workings obligatory under heavy penalties. Also making it obligatory on every mine owner to furnish such maps of his property, and on the mine's officials to properly record such maps that they may be available to subsequent owners.

The gold fields of Nova Scotia have had many desultory and isolated openings made, and the main districts have been more or less continuously worked for over 30 years, therefore it is practically impossible to obtain plans of all the underground workings. But it is not impossible to collect data regarding most of the work that has been done, and one way to make this available was shown in a paper recently read by Mr. John E. Hardman, before the Mining Society of Nova Scotia, on "Government Aid to Mining." Such maps as are suggested in that paper would record the best available data, and would furnish a foundation to which each subsequent year would add its story. The cost to the government would not be great, but whatever the cost this disaster demands that no time should be lost in collecting and recording in some way or another all the data that can now be gleaned by disinterested parties from the men who formerly worked in these mines. Many of these men are getting old, others are leaving the country, and in a few years' time none of them will be available to tell his story.

EN PASSANT.

Owing to an unusual pressure on our columns, our usual yearly review of the progress of gold and coal mining in Nova Scotia has been laid over until the February issue.

Mr. Robert Archibald, M.E., has heen appointed manager of the Joggins mines of the Canada Coal and Railway Company at Joggins, N.S. Mr. Archilbald is an experienced colliery manager. He comes from the Carron Company of Falkirk, Scotland.

Mr. Wm. Blakemore, M.E., of Cardiff, a Past President of the National Association of Colliery Managers, has received the appointment of assistant to Mr. David McKeen, M.P., Resident Manager of the Dominion Coal Company at Glace Bay, C.B.

Mr. John Blue, of the Eustis Mining Company, Capelton, the new President of the General Mining Association of the Province of Quebec, is one of our most successful and highly esteemed mining men in the Province of Quebec. A Scotchman by birth and training, he has been for many years engaged in exploiting the enormous body of copper pyrites at Capelton. The Eustis mine may safely be said to be the banner mine of the province, the ore deposit extending laterally for over two miles, and in depth on the slope of the vein to over 2,000 ft., while at the lowest point, at last report, the ore body is as strong and as solid as ever and has every appearance of continuing so for an indefinite depth. Since it was first opened the Eustis mine has produced about half a million tons of ore and in all liklihood it will produce as much more and probably be a long way from being worked out then. The portrait of the new President published in this issue is from a photograph by Presby, Sherbrooke, Que.

Mr. Ian Cameron, manager of the Dominion Mineral Company, Sudbury, another Scotchman, by the way, has gone to the old country for a brief holiday.

CORRESPONDENCE.

Free Mining Machinery.

To the Editor of the Review:

SIR,—In the December number of the *Canadian Manufacturer* appears an article under the heading of "Mining Machinery," the manifest object of which is to boom the Northey pump, although the writer would have it appear as applying to all mining machinery. There are so many mis-statements of facts, and particularly in reference to the action of the mining associations in asking the Government to be more explicit in the wording of the Act that some reply becomes necessary.

In the first place the mining associations referred to are the General Mining Association of the Province of Quebec and the Mining Society of Nova Scotia. During the past year both of these associations have united in their efforts to have uniform rulings at all ports of entry in regard to the importation of mining machinery, and with that end in view have endeavored to make up lists of such machinery as is entitled to free entry under item 983, and also have urged a better working of the language of the Schedule that there might be no ambiguity and no chance for misinterpretation.

As to the Mining Society of Nova Scotia, I speak whereof I know when I say that all the leading makers of mining machinery in that province are members of that society, most of them attend the meetings regularly, and most of them were represented, upon the committees which have had this matter in hand and which framed the lists which, with the concurrence of the Quebec Association, was forwarded to the Hon. Minister of Customs.

These manufacturers do not oppose the free importation of such mining machinery as is not made in Canada; on the contrary, it is safe to assert that some such importations have brought them increased business, from the duplication of some machines and the renewal of wearing parts in others.

The mining associations of the country have always kept the interests of the home manufacturers in view, and some of the best plants in Canada to-day are fitted with Canadian machinery wherever that machinery can be supplied, and such plants contain of American manufacture only such machines as are not, and at the present time cannot be, made here.

One might go further, and show the illogical nature of this article in the *Manufacturer*, as for example: "If a foreign manufacturer establishes a branch of his works in Canada, or a Canadian manufacturer engages in such an enterprise, then he is handicapped by this free foreign competition," which means (if it means *anything*) that if the Worthington Co. come to Canada and make the Worthington pump here, they then will be handicapped by "free foreign competition," though just how the Worthington pump is to come in free, if it is made here, the Northey pump man doesn't explain!

DURHAM.

HALIFAX, January 28, 1894.

FOURTH ANNUAL GENERAL MEETING

OF THE

General Mining Association

Of the Province of Quebec.

The Fourth Annual General Meeting of the General Mining Association of the Province of Quebec, was held in the new club room Windsor Hotel, Montreal, on Wednesday and Thursday 11th and 12th January. The attendance being one of the largest since the organisation of the Association.

The following, among others, were present:—

John Blue, Eustis Mining Co., Eustis, Que.
George R. Smith, Bell's Asbestos Co., Thetford Mines.
Capt. R. C. Adams, Anglo-Canadian Phosphate Co., Montreal.
H. J. Williams, Beaver Asbestos Co., Thetford Mines.
Dr. F. D. Adams, McGill University, Montreal.
E. D. Ingall, Geological Survey, Ottawa.
E. A. Barlow, Geological Survey, Ottawa.
Prof. W. A. Carlyle, McGill University, Montreal.
George E. Drummond, Canada Iron Furnace Co., Montreal.
T. J. Drummond, Canada Iron Furnace Co., Montreal.
J. T McCall, Drummond, McCall & Co., Montreal.
John J. Drummond, Canada Iron Furnace Co., Radnor.
John J. Penhale, United Asbestos Co., Black Lake.
W. T. Costigan, Cyclone Pulverizer Co., Montreal.
E. B. Haycock, Star Gold Mine, Ottawa.
F. P. Buck, Dominion Lime Co., Sherbrooke.
Col. Lucke, Beaver Asbestos Co., Sherbrooke.
F. A. Halsey, Canadian Rand Drill Co., Sherbrooke.
J. D. Sword, Ingersoll Rock Drill Co., Montreal.
J. Burley Smith, British Phosphate Co., Glen Almond.
Daniel Smith, Hamilton Powder Co., Brownsburg.
Dwight Brainerd, Hamilton Powder Co., Montreal.
J. T. Donald, M.A., Montreal.
A Dick, Joggins Mines, N.S.
Graham Fraser, New Glasgow Iron, Coal and Railway Co., Ferrona, N.S.
John F. Stairs, M.P., New Glasgow Iron, Coal and Railway Co., Halifax.
A. W. Stevenson, C.A., Montreal.
W. S. Gardner, Machinery Supply Co., Montreal.
Fritz Cirkel, M.E., Ottawa.
B. T. A. Bell, Editor CANADIAN MINING REVIEW, Ottawa.
James King, M.L.A., King Bros., Quebec.
Hon. E. J. Flynn, Commissioner of Crown Lands, Quebec.
And the following mining students at McGill: Messrs. Cole, Lambert, Whiteside, Archibald, Van Barrieveld, Hart, Givillaun, Featherstone, Wilkins, Askwith, Rutherford, Webb, Adams and Green.
A. Leofred, M.E., Quebec.

In the absence of the Hon. George Irvine, Q.C., President, Capt. R. C. Adams, Montreal, presided.

The Secretary read the minutes of the last Quarterly General Meeting, together with those of recent meetings of the Council, which were confirmed.

New Members.

The following were elected members of the Association:

J. D. Sword, M.E., Montreal.
W. E. C. Eustis, Boston.
A. W. Morris, M.L.A., Montreal.

Financial Statement.

Mr. A. W. STEVENSON, C.A., submitted the financial statement for the year which showed the total receipts to have been $2,406.42 and the expenditure $2,269.55, leaving a balance in hand of $136.87.

THE SECRETARY briefly referred to the marked increase in the membership during the past year, the interest that had been taken in the various meetings and excursions, particularly the proceedings of the International Mining Convention, held at Montreal during the week beginning 21st February, when the Association welcomed as its guests the American Institute of Mining Engineers, the Mining Society of Nova Scotia and the Ontario Mining Association. The many papers which had been submitted had been of an exceedingly valuable character, and had done much, not only to extend their own knowledge, but also he hoped to attract the attention of the people and capitalists at large to the field for investment in mining open to them in their province and througtout the Dominion.

The Late Mr. W. Hall Irwin.

On motion of the Secretary the following resolution was adopted:

"The members of the Association having learned with profound sorrow of the untimely death of Mr. W. Hall Irwin, a valued and highly esteemed member of the Council; Be it resolved: That a minute be entered in the proceedings of this Annual General Meeting recording the sense of loss sustained by the Association and the mining industry of the Province, the welfare and interests of which he had done so much to promote and further by his integrity, energy and enterprise."

Amendments to Constitution.

The following amendments and additions to the Constitution were adopted:—

Section 10. "The President shall not hold office for more than two consecutive years, but shall be eligible for re-election to that office after an interval of a year."

Section 12. "All officers and members of Council shall retire annually, but shall be elegible for re-election."

Section VII. "When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form "B," but his name shall not be added to the list of members of the Association until he shall have signed the Form C in the appendix."

Section XVI. "General meetings for the reading and discussion of papers and for the transaction of business shall be held once in every four months in each year, at such time and place as the Council may determine.

Affiliation of Mining Students.

THE SECRETARY stated that at one of their Council Meetings the question of affiliating the McGill Mining Society, which was an organisation of the mining students attending the lectures at McGill University, had been discussed, and Mr. Carlyle had written to say that the matter had been favorably entertained by the students. On motion in was decided to refer the matter to a meeting of Council to determine upon a basis for such affiliation.

A Canadian Mining Association.

THE SECRETARY stated there was a very favorable disposition among many of the members towards the incorporation of the existing mining organisations into one strong body, which while representing the Provinces would be thoroughly representative of the mining interests of the Dominion. Certain prominent members of the Mining Society of Nova Scotia were also strongly in favor of such an amalgamation.

THE CHAIRMAN—The idea is a capital one and I think that we should make a move towards carrying it out.

MR. F. A. HALSEY was heartily in sympathy with such a move. The Council, he thought, might draw up a proposition and submit it at their meeting on Thursday, it could then be left in the hands of a sub-committee to enter into negotiations.

On motion the matter was referred to Council to report.

Election of Officers and Council.

The meeting then proceeded to elect officers and Council, the various ballots resulting as follows:—

President:

John Blue, Eustis Mining Co., Capelton.

Vice-Presidents:

J. Burley Smith, British Phosphate Co., Glen Almond.
George E. Drummond, Canada Iron Furnace Co., Montreal.
F. P. Buck, Dominion Lime Co., Sherbrooke.
Col. Lucke, Beaver Asbestos Co., Sherbrooke.

Council:

James King, M.L.A., King Bros., Quebec.
Capt. R. C. Adams, Anglo-Canadian Phosphate Co., Montreal.

F. A. Halsey, Canadian Rand Drill Co., Sherbrooke.
S. P. Franchot, Emerald Mining Co., Buckingham.
Hector McRae, Electric Mining Co., Ottawa.
R. T. Hopper, Anglo-Canadian Asbestos Co., Montreal.
J. J. Penhale, United Asbestos Co., Black Lake.
George R. Smith, Bell's Asbestos Co., Thetford Mines.
Fritz Cirkel, M.E., Ottawa.

Treasurer.

Mr. A. W. Stevenson, C.A., 17 St. John St., Montreal.

Secretary:

Mr. B. T. A. Bell, 17 Victoria Chambers, Ottawa.

To Meet in Quebec.

After discussion it was unanimously resolved to hold the next meeting in the city of Quebec during the first week in June.

The meeting then adjourned.

EVENING SESSION.

The members reassembled at eight o'clock, Mr. John Blue, President, in the chair. The club room was crowded, there not being seating accommodation for all present. The first paper was:

The Diamond Prospecting Drill in Mining Canadian Phosphate and other Irregular Deposits..

By J. Burley Smith, Glen Almond, Que.

It is generally held that the diamond drill is not of the same utility in prospecting and determining the position of irregular deposits as it is in minerals of more regular occurrence.

This is more from the fact of the great results achieved in determining accurately the area, extent and depth of regular deposits scientifically located, than failure to discover the position of acknowledged uncertain deposits.

However great the service rendered with regard to regular deposits, it will be remembered that the value of the diamond drill as a prospecting tool became first properly appreciated from the remarkable discoveries made through its use in the great hematite deposits of North Lancashire and Cumberland, England.

Deposits, which from their apparent fitfulness and irregularity had been worked only on a small scale, and as mere surface pockets occurring here and there over a considerable area of ground, and abandoned when apparently exhausted, until the boring operations of a few enterprising proprietors taught the lesson that, although the character of the ore seemed irregular, similar deposits occurred at much greater depths, and of much greater magnitude, the irregularity, scientifically considered, being but another form of regularity and the peculiar order in which these deposits were to be looked for.

Subsequently, and chiefly owing to the use of the prospecting drill, these mines have been worked to a very great depth, and much more extensively, turning out annually many hundreds of thousands of tons.

And the great number of successful results of recent years in such deposits, in all parts of the world, appears to indicate that the diamond drill is of even greater utility in prospecting these than in the more regular minerals referred to.

The very irregularity which makes some kinds of mining so uncertain shows the necessity of traversing and searching the zone of occurrence in many directions by some method much more rapid and less costly than by shafts and tunnels, and a tool like the diamond drill, capable of drilling from 20 to 40 feet per day and bringing out cores of the material passed through, seems to fulfil, in a great measure, these required conditions.

Through its use, prospecting of a mineral property can be exhaustively and reliably carried out in a few months, and cross sections delineated, showing the number and size of the deposits, from the plotted profiles of which the quantity of ore contained may be approximately calculated, showing if the quantity discovered is large and near enough to bear the greater expense of sinking a shaft or driving tunnels to reach it.

Thus, by the expenditure of a few thousand dollars in the prospecting machinery and the cost of the necessary boring operations, the owner of a property is able figuratively to cut his property into slices and see what is inside. The accuracy of which depending, of course, on the number of cuts made.

And, instead of risking a large sum in the purchase of a costly permanent plant and machinery to begin active mining operations for a mineral only doubtfully believed to exist, it may be ascertained by a properly arranged system of borings (practically constituting an approximately accurate underground survey showing the extent and location of detached and irregular deposits) whether it is advisable to lay out money in plant at all, or how much, and even if it is advisable to mine a property or not.

If valuable the very best machinery can be laid down without hesitation or risk for the most economic method of sinking or driving to and winning the mineral when reached.

At the same time an approximate knowledge of the quantity, making it feasible to determine in advance all the questions of transport and annual yield, the laying down of tramways and and the transport generally and the use of available water or other gratuitous power to the best advantage.

Negotiations for sale or purchase would also be much simplified from the fact of the real value of the mining estate being established, the cores of mineral and country rock, with the accompanying chart and sections being the best evidence of the character of the property.

In mining phosphate of lime in Canada the prospecting drill is certain to prove of the greatest possible service.

It is now pretty clearly demonstrated by those eminent Canadian geologists who have earnestly investigated the phenomena of occurrence of this peculiar mineral, that it is found, with rare exceptions, in detached masses or pockets sometimes resembling veins, in masses of pyroxene which originally considered as interbedded portions of the structure of the Laurentian rocks, are now generally acknowledged to be intrusive dykes, probably connected with the basic eruptions of Archean date.

Very recent observations made in the actual mining of phosphate corroborate in a remarkable way these conclusions, and give at once a basis from which to start in searching for the mineral.

The question of irregularity and uncertainly of the phosphates are not disposed of, but the occurrence and form of the pyroxene are shown to be not irregular and it may be easily recognized.

It is well known that these pyroxene zones, belts or bands, or whatever name they are distinguished by, are readily found and their boundaries clearly defined.

Granting this it will be seen that the field of operations for the diamond drill prospector is not unduly large, and that a comparatively few carefully selected bore-holes will show if the zone is rich in phosphate or not, the character of the deposit, rich or poor, generally prevailing throughout, and if it is desirable to make further and more conclusive tests, or proceed to another field without loss of time or money.

If a number of vertical borings, placed at fixed intervals with their situation carefully recorded on plan are made and a proper register kept, together with the drill cores brought to the surface, a number of accurate profiles may be constructed, showing a faithful section of the ground tested and whatever it contains. And if parallel lines of borings be made at a convenient distance it will be seen that the area of these respective profiles multiplied by the parallel distances apart will give approximately the quantity of material lying between, whether of unproductive ground or a deposit of mineral.

My own experience in diamond boring in phosphate deposits has been confined so far entirely to underground work, *i.e.* in testing the ground in search of deposits lost track of, or cut out, or new ones believed to exist, but I am able to testify to the success attending those borings made and profiles taken which proved the existence of several valuable deposits; in one case fully corroborated by the extension of a drift to it. And knowing the distance exactly, and the kind of rock intervening, we were able to let the driving of this by contract and on very reasonable terms.

I regret from the fact of our boring operations being yet incomplete, that I am not at liberty to give full figures and details, but hope on some future occasion to return to the subject and publish a full account of this work, which has proved valuable and interesting to me, and may be of use to other phosphate miners.

I will therefore conclude with some description of the machine in use at our mines, which has given the greatest satisfaction, absolutely costing nothing in repairs during the six months we have had it in daily use.

The diamond drill we have in use is the Bullock drill and of the prospecting type, it is capable of boring holes up to a depth of 1,200 feet, in hard rocks such as gneiss or diorite it will bore at the rate of about 20 feet per day of ten hours, and in phosphate, one foot in three minutes, and it requires about four horse power to drive it efficiently. It bores holes of 1¾ in. in dia. bringing up a core 1⅛ in. dia

The motive power is supplied by a pair of light and compact trunk engines, fitted with slide valves of novel construction, which permit the using of the smallest possible part, and reducing the clearance to a minimum, thus effecting a large saving in the use of compressed air.

It is light and portable and can be used with equal convenience on the surface or underground, and will bore in almost any direction.

It is unnecessary to give further particulars here and I will therefore refer enquirers for more to the catalogue of the makers.

Finally, however, I desire to express the opinion that the diamond drill is equally useful in prospecting for mica, graphite and all minerals of more or less irregular occurrence.

As a mining tool in every day operations it is of the greatest value—in testing ground ahead, in sinking, driving or stoping, and it is not infrequently used in boring blast holes as well.

Discussion.

The paper was ably discussed by Messrs. George R. Smith, Capt R. C. Adams, W. A. Carlyle, F. A. Halsey, E. D. Ingall, and the Chairman.

Mine Tunnels and Tunnel Timbering.

By Mr. W. A. Carlyle, Montreal.

Location—In the selection of the site for the tunnel-entry care is taken to choose a place (1) as easy as possible of access by trail or road, (2) but chiefly the lowest point, so that the greatest possible area of the ore deposit may be worked over-head after the tunnel reaches it, and at the same time be drained naturally of water, all geological data having been sought out by surface examination and test-pits. Good and sufficient dumping ground is also provided for, care being taken by survey if at all doubtful, that the tunnel will be on the right territory and that the waste rock on the dump will not fall so as to trouble other property or block public roads, or by any possible means incur litigation or impede future mining operations.

Often in the early life of a claim to develop the character and value of the ore-body, a tunnel is run at a point high up so as not to be at first of too great length and cost, but afterwards a longer tunnel is driven in at a much lower level after the upper one has proved the claim to be good, and enriched the none too plentiful supplies in the company coffers. Again a tunnel may sometimes be profitably driven as from the other side of the hill or mountain, so that its mouth will be in a most advantageous position for connection with an aerial wire-rope tramway, by which arrangement although the first cost will be more, the cost of transport of ore from the stope to mill or railroad will be so lessened as to quickly repay the extra initial outlay. For this reason it may be wiser to use a tunnel instead of a shaft, even if the latter is much the more preferable for the mining of a deposit, and when work must be done below the tunnel level. This is now rendered very easy by sinking inclines and placing at their head rapid and powerful hoists operated by electricity or compressed air, and if water is encountered, pumps can now be got that will do beyond peradventure, most efficient work with either of these sources of power.

In all cases the tunnel must be run right straight for the vein, and for this it may be well to call in the aid of the surveyor whose directions should be then closely followed, for if even a slight deviation is made, say to work along softer ground, one's course is quickly lost under ground and a queerly shaped tunnel is the result. This direction is easily kept by lining in the miners with plugs driven into the centre of the roof and plumb-bobs suspended from them, or using stout screw-eyes in the caps of the timbering.

Dimensions—In metal mining tunnels $4\frac{1}{2} \times 7$ ft. for single track, and 8×7 ft. for double will be amply large when no timbers are used, but with timbers $4 \times 6\frac{2}{3}$ ft. in the clear for single, and $7\frac{2}{3} \times 6\frac{2}{3}$ ft. for double will permit the easy haulage of much material, but still be none too large. In a small cheap prospecting tunnel $3\frac{1}{2} \times 6$ ft. will suffice.

Grade—The best average grade in good work is 6 in. per 100 ft., giving a rapid fall for water and equalizing the work of taking out fulls and returning the empties. A 1 per cent. grade common in levels, with a good track will permit a trammer to ride out but he will have a heavy push back especially with iron and timbers. Miners left alone will quickly work in a steep grade, they will never run level, and in good work the grade is easily kept by using a 16 x 20 feet straight-edge cut to the proper inclination and a spirit level, laid along the mudsills, and checked with level and rod every 100 or 200 feet, for 6 in. per 100 feet too much grade in a 1000 feet means 5 feet less of stoping ground.

Equipment—In developing a claim by tunnelling the least amount of equipment is required. If the work is to be done with the very least outlay of money a small stout shed or blacksmith shop is erected over or near by the entry and fitted up with forge, anvil, bench, vises and sufficient appliances to keep all the mining tools in good condition such as drills, hammers, shovels and picks, and also with such supplies necessary for repairing the cars. Often all the blacksmith work is done by one of the miners working part-time in the shop, but if one man is needed just for this work, during spare hours he may be engaged in building more cars using bot-wheels, or else in cutting out mine timber setts. In more extensive work where machine drills are used, a simple and not expensive engine house is built, say 40 x 40 feet, divided into (1) the compressor room in which are a 4 x 6 drill compressor, the receiver and two steam pumps, one for boiler feed the other for supplying cold water to the compressor, (2) coal bunkers, (3) a small store room, and (4) the rest of the building has a sufficient boiler, a large bench with vises, tools and fittings for repairing the air drills, etc., and also a small hand drill. Around near the boilers are benches and hooks for the miners' use, warmed in winter by the exhaust steam. At a very large tunnel-working in Colorado often to be referred to, and in which the writer worked, the cost of such an engine house thus supplied was $8,700, while another $1000 was spent on two other buildings, a well equipped blacksmith shop and a timber shed on either side of the track near the tunnel which was double tracked and driven 6,000 feet at a cost of $125,000, with such an equipment, the first 3940 feet taking exactly two years to accomplish, being delayed by hundreds of feet of tremendously difficult and dangerous ground.

If two drills are being used a third should be kept in the shop, also a good supply of track-iron, piping, sharp drills, etc, trying to anticipate always any wants that otherwise might delay work. If good water power is available excellent machines are now made by the using of which power, the cost of this kind of work can be greatly reduced.

As to houses and eating quarters for the men, I think company money should not be spent on these as good men can nearly always be got who are willing to work and also to build their own houses or shanties. Even the manager or superintendent should be content with humble quarters if in a new region, until the mine warrants more expense.

Ventilation—When the tunnel is run a short distance some means of conveying fresh air to the face must be provided :—(1) By hand blower set up at entry and pipes 4 x 5 inches diameter ; (2) by a tight wooden box, 1 foot square, running into the face and having its outer end running up the hill to create a draught ; (3) by some regular form of blower or exhaust fan, as the Root or Baker, driven by water or a small steam engine, using piping 8 x 12 inches diameter, spiral, welded and tight joints ; (4) by discharging compressed air at intervals as found so successful in the large Pratolino tunnel, Italy, 3,600 metres long ; (5) or by perhaps the best and cheapest method of all, *i.e.*, using pipes 8 x 14 inches diameter, with tight joints, running nearly to the face, introduce in the pipe near the tunnel-mouth a Korting exhaust (made in Philadelphia) which is about 3 feet long and the same diameter as the pipe. To this conduct through a ½ inch pipe live steam of 60 to 80 lbs. pressure, or as usually used, compressed air, which is allowed to blow off in the exhaust in a direction towards the mouth, a vacuum tends to form quickly behind the jet and at once a strong current of air begins to flow along the pipe from the heading and it is surprising how great is the efficiency of this cheap and simple exhaust ventilator. I have often seen in this big tunnel, with the air hose for two drills open to supply more fresh air, an 8 inch pipe thus have the air fresh and good in twenty minutes after the firing of 25 holes loaded heavily with dynamite. Of course as the tunnel gets long, the air along it may get sluggish and poor except near the heading, and as soon as possible natural ventilation should be secured through another connection with the surface, or the decay of the timbering will be very much more rapid. In using the drills the exhaust air from them is aiding very materially but this is not enough in itself after the work is 800 or 900 feet long.

Drainage—In cheap work, even in very good work, if a large flow of water has not been anticipated, water when struck is allowed to flow out over the floor, planks being laid between the rails to keep the men's feet dry, but this is a wet, dirty way, especially near the entry in winter time. Much better is it, remembering that water is almost a certainty, to prepare to confine it in a trench or small box along the side, or if a large flow may be expected, to put in water boxes from the first under the centre of the mud-sill (Figs. 4-7) at very little extra cost, such a box 12 x 16 inches, with ½ % fall, safely carrying 2,000 gallons per minute. I have seen a torrent pouring from a tunnel when it was then necessary to make the timber sett higher to permit the putting in for the tracking of a second sill 12 x 14 inches, above the mud-sill, just such as is seen in the Sutro tunnel of the Comstock.

Illumination—Around where the miners are at work, as at the face, the paraffine candle is by far the best illuminant, as it can be put anywhere and does not vitiate much air as do the foul-smelling, dirty coal oil lamps or torches that must be used in very wet places. The electric light is of course most efficient for permanent lighting, all wires being well insulated and the lamps usually with a wire mask, but *no* key for turning on and off the current. These protected incandescents can be used at the face, but are not as convenient as the candle in a miner's stick.

Explosives—In tunnelling only some form of dynamite or giant is the explosive used, giant No. 1 or 75 % nitro-glycerine being used in the centre cutting holes, where a concentrated effort is required in blowing out this central wedge of rock, while in the following or side holes when greatest effect is gained by spreading the energy of the blast over more space, giant No. 2, or 36 to 45 % strong is used, lower grades being discarded in all such work. These explosives, bought at a cheaper rate when in a considerable quantity, are best stored in a small vault or room excavated from one side of the tunnel near the entry, well boarded up and floored so as to be perfectly dry, with double doors, one locked, and good ventilation. Here it will be safest from any harm, as fire, lightning or mischief and liable to freeze only a little. The boss should prepare the cartridges, knowing just about the number of sticks needed, and then take them in at loading time when he sees that this important part is properly executed. In small work the miners usually carry in the necessary powder stuck down in their boot-leg and fire the holes as soon as ready.

In thawing out giant, which by the way should not be kept too long in stock, or over 1½ years, some simple arrangement is easy if there is a steam engine where a small box can be heated by the exhaust or live steam, but if a large amount is being used daily, it may be better to have a small house 6 x 6 ft., with racks for holding the stacks and trays of sawdust beneath, all heated by steam, and with a good supply of powder thus kept ready the cartridges can be safely made on a broad shelf opposite a window, without running the chances of danger always liable if this work is done, say, in the engine room. With a small Brunton fuse nippers cartridge loading is done much better and quicker, as with the nippers the fuse is cut square off and compressed so that it slips easily and snugly into the fulminate end of the cap, which is then fastened tightly on by an incircling squeeze from another part of the same tool.

Firing—If the tunnel is being driven by hand drilling, the shots are always exploded by simply snuffing or igniting the fuses with the candle, but with air drills the battery is much used, first firing the centre cutting holes and then the remainder, although if the timbering is kept close up to the face, this method is found to be harder on it, and for very good reasons many superintendents prefer lighting the charges by hand, making the fuses of the centre, or over, or undercutting holes shorter, so as to fire first and give the other shots their maximum efficiency. In this large tunnel where the driving was hard and fast, the battery was used for some time, but returning to hand firing it was found more satisfactory, as the preparations for shooting were quickly made, the rotation of shots was nearly controlled, the timbering not nearly as badly hammered up, and the number of missed shots small. These missed shots were easily set off by carefully cleaning out the hole nearly to the charge by the man who loaded it, and then inserting a small cartridge of a new fuse and half a stick that seldom failed to detonate the original charge, the ventilating exhaust described quickly drawing off the hot, smoky air, thus delaying work but a little. Such shots must be very carefully watched, especially if a large number has been exploded, for should the drill strike one that has been overlooked a bad explosion will ensue. One of the superintendents of this tunnel, afterwards in another mine, was caught in just this way while going his rounds, and on stepping up to the machine just as it struck the charge the man had neglected to notice had not exploded.

Mining—Tunnelling is begun by making a good entrance, if in rock, by putting in a strong well-cut set of timbers and a good door or gate ; if in wash, by clearing away at once all loose stuff and timbering or walling up the approach to the opening to prevent caving in of the banks after heavy rains or in spring. For the first 100 feet or so wheelbarrows may be used for taking out the waste which at first is disposed of in levelling up outside and preparing for the tracks to the dump. Timbering will be needed until well into the rock, and usually close lagging, as water working through the wash would otherwise bring much soft stuff into the tunnel, besides the timbers are best kept close up to the face to forestall much unnecessary excavation, and to bar against the accidents liable in this often dangerous material.

The putting in of good solid tracking from the first will soon repay the extra cost, as it is surprising how the progress is increased by the use of good cars and tracks, when the maximum work can be got out of the trammers and the horses or mules, and vexatious and expensive delays caused by cars leaving the rails reduced to a minimum. The rails of at least 16 lbs. per yard, but preferably 24 lbs., are laid on the mud-sills or on stout ties 4 feet apar and ballasted between with waste to make a good footway, or else planks are spiked down between the rails that have an 18 or 20 inch gauge carefully set. In this big tunnel 36 lb. steel rails made a firm steady track over which with ½ % grade a 900 lb. mule easily pulls in a train of 12 or 15 heavy steel cars or trots out with the same loaded with 12 to 20 tons of rock or ore, a brake being necessary to control when going out.

Steel cars holding ¾ to 1½ tons of rock and with the wheels running loose on the axles are generally used but if much wet gritty stuff is being carried out that dripping down quickly cuts the axle bearings. This rapid and very harmful deterioration can be checked by putting on self-oiling wheels that are now made in a simple manner to protect such bearings. As the bottom of the car box is the first place to wear out from the constant fall of rock and this is an awkward place to patch or renew, the blacksmith should fit in the new car a false bottom of 1 inch pine and $\frac{3}{16}$ inch boiler plate bolted to the floor of the car which will protect the car itself and can be quickly replaced when worn out. Such details greatly lengthen the life and also reduce the cost of the rolling stock besides decidedly improving the efficiency. In a double track tunnel it is very convenient to use near the face a temporary switch and single track of light iron that can be lifted up and carried ahead, by which an empty coming in on its track can be run on this single track in the centre, much more easily shovelled into and worked about and when filled, be pushed upon the other track to wait until the whole train is ready. On the outside a simple device will save a man's time or the unnecessary stopping of the train when under full way and the otherwise great liability of the cars leaving the track at this point, and this is an automatic or simple spring switch where the two tracks merge into the one to the dump, that allows the car coming out to pass on to the dump-track, but returning the switch is always and only open to the ingoing truck. As to the motive power when the tunnel gets long or over 1,000 feet, the trammers should give way to a horse or mule that will soon become accustomed to working in the darkness with perhaps only a lighted candle at the curves. In a completed tunnel not over 1,600 feet in length and a grade of not less than 1 % haulage is made very easy by putting at the inner end where it connects with the deposit, a 10 or 12 h.p. motor that will quickly pull in a train of empties that runs out full, dragging the steel cable and is checked at the entry by the motorman at the motor at the inner end.

The majority of tunnels are, perforce, driven by hand drilling and good progress thus made. Comparative tables as to the cost of driving by hand or machine are not available, but in the west with even the very high price for labor it is well understood that the advantage gained in the use of air drills is in *time* but not in *cost*, therefore I think one should hesitate before installing such a plant, to count the cost and to decide whether the work had better be rushed with all speed and whether the compressor and drills can be put to real use after mining commences. In some camps compressed air becomes a perfect fad and every superintendent thinks himself behind the times if not using it. In a single track work 100 to 180 feet per month by hand drilling is quite possible if the rock is not extremely hard, but with air drills the rate should be from 250 to 330 feet, 300 feet being good driving. In the big tunnel mentioned with 2 drills working in shale and afterwards hard dolomite, and breaking as much rock as the shovellers could well handle, the men were allowed pay as for two extra shifts if 300 feet was the month's advance, and it was astonishing to see the way they made the rocks fly and resented any delays, the result being that 320 to 330 feet was repeatedly the month's progress, while the star record for one month in softer dolomite, was 379 feet or 12½ feet per day.

If a head of 40 to 100 feet of water from a flume is available the compression of air is greatly cheapened by operating the compressors with Pelton water wheels. The electric percussion drills now in the market have not as yet proved a decided success, but in time technical defects will surely be remedied.

In hand drilling the placing of the holes depends greatly upon the character of the rock, although this influences but a little machine drilling, in which two vertical rows of holes are drilled toward one another in the centre for breaking out the central wedge, and then parallel rows of somewhat deeper holes and such squaring up holes as are required. Again 3 or 4 converging holes near the centre especially in small tunnels, will suffice to make a good centre cut, and concentric rows of holes will complete the work, but all machine men have their hobbies and a really good man will make much faster progress than one who knows how to handle the drill but not select the position for the holes. It might be said here that greater effect is secured by firing these centre cutting holes by electricity, but the others are fully efficient when snuffed.

Timbering—It is seldom that the rock in the tunnel will stand long without support excepting some classes of granite syenite, gneiss or firm limestone or sandstone, and as the primary object of timbering is to *prevent*, not *check*, the movement of the ground, it is generally best to timber up at once if the rock is at all liable to be weak, as so often the rock under strong tension will collapse without any warning or immediately after examination, and timbering will then be far more expensive in the end.

Spruce, pine and hemlock are mostly available for such service in our American mining and then they are best if the trees have been killed but not damaged by fire and stand straight, dry and strong, as the green wet stuff is very heavy to handle under ground. Such timber cut above altitudes of 7,000 or 8,000 feet was found in Colorado to be much inferior in strength to that from lower down, being less resinous and brashy.

Some sketches have been made to show the styles of timbering mostly used in American tunnels, those requiring the fewest cuts and simplest framing while preserving the maximum strength.

Fig. No. 1. shows a cheap sett consisting of cap and posts of round timber and poles split or unsplit for logging.

Fig. No. 2. is a full set of round timbers better framed with or without collar braces.

Fig. No. 3. shows a sett for single-track with different kinds of joints, and of timber sawn on two or four sides.

In putting in the timbers every sett is made perfectly firm with wedges and blocks on top and sides, and in logging up if the ground is not very wet and loose, the logging is spread out, not put close together, by leaving out every other piece and filling in between with bits of rock, and to make the most of the logging's strength it is put in with the *round* side next to the timbers.

Figs. Nos. 4 and 5. show the sett used in the double-track tunnel mentioned, with collar braces and water box. Before framing, the sticks were squared on two sides by two French Canadian axemen, at a cost no more than that of the timber squared at the mill, as was afterwards used in the arched setts. This form and size of sett was found to stand very heavy ground even when spiling had to be used, but finally it was supplanted by the arch sett, (Figs. Nos. 6 and 7.) when the pressure became excessive and as it was better adapted to spiling. This sett was designed to give ample room for working, but in the least possible space and with the simplest form of of framing. It withstood tremendous pressure when the cost of progress for some time was $600 per foot, and only in one place where crossing a bad water course, were extra intermediate setts needed besides those with four-foot centres.

For the framing, good drawings were given the carpenter, who then made very accurate templets, by which the different pieces were quickly marked and cut so that each set always fitted together perfectly. If a sett ever did show signs of collapse another was at once put in beside it, and where the tunnel had passed through some porphyry that afterwards swelled and forced the timbers all out of shape, the only relief was gained by every little while working away the rock behind the timbers until this swelling ceased.

When bad running ground is met with, the greatest care is imperative lest the men be suddenly overwhelmed or hundreds of feet of the tunnel filled up in a few minutes. The timbering being right up to the heading that threatens to burst in, this is prevented by slipping in the breast boards or horizontal planks across the face between the last sett and the rock, then over the cap and behind the posts are driven out the chisel pointed spikes, 3 in. x 6 in., 7 ft. long, as far as they will there go. Next begin at the face by working around the top breast-board until it can be pushed ahead 6 to 12 in. and held there by props against the sett, and then the other planks down to the bottom. As soon as possible the "false sett" is put in place to prevent the spiling from closing in too soon, and I believe the best, handiest and cheapest form of false sett is that used by Mr. D. W. Brunton in this tunnel. When in the wash very difficult ground had been traversed by spiling, but the old method of keeping the heading open until a new sett could be put in, by holding the spiling out by any possible prop or scheme, used a great amount of timber and allowed an immense deal of sand and mud to enter the tunnel. With this new device the work was wonderfully simplified and much better controlled. Two strong posts notched at the foot to crowfoot into the corners of the windsill and posts, supporting on their top rods a length of 5 in. gas pipe bent to a shape to correspond with the timbering used, were fastened to the cap of the last sett by turn buckles and rods passing through near their heads. This last sett was tied back to the next sett with turn buckles and rods passing through holes near the four collar braces. Now, when the breast boards had been gradually and laboriously worked forward far enough, and held by stays that could not obstruct the new sett, this was now set up, the hanging put on to keep the spiling from pressing down directly on the timbers, and reserve a space through which the new spiles should pass, and then by loosening the turn buckles the false sett was lowered until the enclosing shield of spiles rested on this new timber and four more feet were won. If a great flow of water and sand under great pressure is experienced about all one can do is to let it drain until it lessens or stops, as will be the probable result. One detail in this kind of work must never be forgotten—100 feet or so back from the face, and perhaps again at 200 feet, is kept a supply of planks of proper length so that should the breast suddenly give way, the miners running back can at once build up a dam or bulkhead by laying these planks across the tunnel against the timbers. This is generally done in the dark, the sudden in-burst extinguishing the lights, and the treacherous sands may pour in as fast as the men can run. In a larger tunnel in the same place through neglect of this precaution, 600 feet of the tunnel was thus filled up and temporarily lost, necessitating much (what might have been avoidable) expense in its recovery.

Notes on the (White) Mica Deposits and Mines of the Saguenay Region.

By J. Obalski, Inspector of Mines, Quebec.

This district, from a mining point of view, is an entirely new one, the first working having been commenced in the fall of 1892.

Sometime prior to this date, it was known that mica existed at certain places, but no attempt was made to work it. Recently, however, the increased demand for mica, by reason of its extensive use in the generation of electricity and its accompanying requirements, caused prospectors to take the field, and certainly the results have proved satisfactory and gratifying.

The locality most prominent in this district at present, is in the Township of Bergeronnes, Saguenay County, and situated about twenty to thirty miles below the village of Tadousac, and at a distance of about ten miles from the shores of the St. Lawrence.

In addition to the discoveries made in above mentioned locality, indications have been found in the adjoining Townships of Tadousac and Escoumains, also in the valley of the River "Aux Canards," on the other side of the Saguenay River.

The formation belongs to that of the Lower Laurentian, the country rock being mainly feldspathic and dioritic gneiss frequently crossed by trap dykes, easily discernible on the formation bordering the Saguenay River.

The character of the country is, generally speaking, barren, and is as yet unsurveyed and belongs to the Crown; the facilities for transportation, although one would think differently at first, are in reality good, by following the valleys of the streams running to the St. Lawrence.

Numerous veins of quartz and course granite traverse the country rock, and in some instances are of great magnitude, we will only consider the latter kind. The elements, quartz, feldspar and mica, are well separated and in some places large enough to warrant the name of mica mines being applied to them. The general direction of the veins is N.E., the dipping, as well as the forms of same, being variable.

While prospecting this district I met with several of these veins, not less than fifteen in number, well defined and worthy of consideration, but they do not all merit the title of mica mines; sometimes the mica being too small, or the veins themselves too narrow to admit of being profitably worked.

I will now give some details concerning the two most important properties and which have been developed with a marked degree of success. The kind of mica found in this district is uniformly of the white (muscovite) variety, and of a brownish color when in thick crystals, whereas the same variety in the Ottawa Region is invariably green under the same circumstances. It is remarkably clear, free from spots, is elastic and the cleavage is excellent. I have not any minute test of this mica, but have seen by the correspondence of the operators that it is highly appreciated and the demand is much in advance of the production, up to the present time. The mica is used for stove and also for electrical purposes.

The McGie Mine—This mine is the property of Daniel McGie, Esq., and others, of Quebec. It is situated in the Township of Bergeronnes (block G), twelve miles from Escoumains Bay. It comprises an area of 58 acres. The vein, about a quarter of a mile long, which crosses the property in a N.E. direction, is crooked, and the dip is on an average about 40° N.W., and crosses the stratification of gneiss county rock. This mine, the pioneer property of the district, was opened in October, 1892, and was worked during the summer season with a force of not exceeding ten men.

At the southern extremity of the property the vein is 15 ft. to 25 ft. wide, and was operated on a length of 140 ft. by means of an open trench 15 ft. deep and a shaft 25 ft. deep. About 15 tons of undressed mica have been taken out, from which 15% of dressed or cut mica has been obtained and marketed. The largest pieces produced cut 7 x 10 in., and the average may be considered as 3 x 4 in. In addition to the above, I may say that roads have been constructed and the necessary buildings erected. From the south to the other extremity of the mine, the vein gradually widens and expands until a width of 55 ft. is reached, showing numerous crystals and as yet untouched.

The feldspar (orthoclase) is found, as usual, in large quantities, and appears to be of an excellent quality. Crystals of black tourmaline, garnet and emerald (beryl) are found, the latter sometimes 3 in. in diameter.

Beaver Lake Mine (Bergeronnes, Block H)—This mine is the property of P. P. Hall, Esq., and others, of Quebec. It is situated at the head of the Little Bergeronnes river, in proximity to Lac-aux-Sables, and about 11 miles from the shipping point on the St. Lawrence, of which distance 6 miles is preferably traversed by water in crossing said lake. The area comprised is 100 acres; the veins run N.E. on a length of one mile, with a vertical dip; about one half the length of the vein has been prospected, showing same to carry a width of from 100 to 300 ft. as per the latest reports. While inspecting this property I measured one exposure 140 ft. wide and several others of 100 ft. in width, with numerous crystals in sight. An exceptionally fine view of the vein is obtainable from the base of a cliff 50 ft. high by 142 ft. wide, including a strip of barren rock about 20 ft. wide. Here and there a large number of crystals of merchantable mica may be observed, disseminated all through the vein, in some instances capable of cutting 4 and 5 x 6 in. The mine is as yet unworked, prospecting work only having been done so far, but the appearance leaves no doubt as to its value.

These two properties are the only ones in a workable condition at present, but numerous other places have been held under prospecting license, and the results although not so encouraging, have firmly established the fact that several other veins of similar character exist, some of them not workable but others favorably situated and which in all probability will be developed next season.

Labor in this district is plentiful at current prices, but the men are not accustomed to mining work, nevertheless with a practical man as superintendent they soon become skilled. The original prospectors had no knowledge of mining to speak of and especially as regards mica. It is necessary to erect buildings at the mines, as the hands have to be housed there. Cost of transportation from the two working mines at present would not be more than 15c. per 100 lbs. from the mine to the shipping point on the St. Lawrence, and from there to Quebec by schooner say 10c. per 100 lbs. or $5.00 per ton to Quebec, including the handling. If the mica were selected and dressed at or near the mines, the above figures as applying to cut mica are very moderate.

I must again repeat that the district is as yet unsurveyed and the prospecting was done by people very slightly experienced in such work.

I cannot give any better or more illustrative idea of this country than by comparing it with the Ottawa phosphate region, the important mineral here being of course white mica, and the principal veins, quartz and coarse granite.

In conclusion I would remark that if there is a future in store for the white mica industry, there is here a large field for research and investigation, and which may well repay practical and intelligent prospecting.

In addition to above notes I would mention that while mica, in workable deposits, has been located at Lake Manowan, near the head of the Peribonca river, 250 miles north of Lake St. John; at Watsheshos on the Gulf of St. Lawrence, about 400 miles below Tadousac; and also at Lake Pieds de Monts, 17 miles north of Murray Bay. These properties, I must observe, however, to avoid confusion, are not in the same district, although of the same character and containing the same variety of mica, viz: muscovite.

Discussion.

Capt. R. C. ADAMS—I do not know that I can say anything about this interesting paper, but if I am allowed I might say something in regard to the mica industry. It has interested we phosphate miners very much because we have found mica in connection with the phosphate and until the last two years have been in the habit of cursing it and throwing it away; but now that the product is extensively used in electrical practice we have turned back to the old abandoned pits and have gone to work to extract the mica and we think now that the case is just reversed, whereas when we were mining phosphate the mica came in, now that we are mining mica the phosphate comes in, and if I go to a pit with a fine vein of mica it often gives place to phosphate which formerly I would rather have seen. We find the occurrences of mica so irregular that it is hardly profitable to mine except when one gets large sizes and many miners have abandoned its production, but if phosphate prices advance I think the properties that have phosphate and mica together will be profitably worked. The prices quoted may at first sight seem high, but when you come to have your mica culled over by the purchaser's experts and find that four-fifths goes with the pile valued at $25 per ton, whereas only a small remainder goes into the one hundred dollar pile, you will find that your average price is low. The first lot of mica that I sold averaged $80 per ton and encouraged by that I went on and got out a large quantity which, after being culled over by the buyer, averaged $35 per ton. I resolved to make one more effort and obtained a large quantity of mica and after two or three months' effort to sell it, finally succeeded in working up the figure to double the former price. I shipped a sample ton lot of this to the States, and to my surprise it was seized on the ground of undervaluation, although it was valued at double the price I had ever sold at before. I went to New York State and found the Inspector, who produced the retail price list of the dealers who buy from the miners and he declared that to be the market price at which the goods should be invoiced. Nothing would convince him to the contrary. My mica was seized and the valuation raised and I was told that I had made myself liable to a fine of $250 for not invoicing it at the retail price. From experience I have found it most profitable to sell the product in the rough and let the dealer cut it and retail it to the consumer.

Mr. J. BURLEY SMITH—The merchants in London, England, complain of the want of regularity in prices on this side. It seemed as if nobody knew exactly the value of the article and producers were all trying to get as high a price as possible.

THE CHAIRMAN here called upon the Hon. E. J. Flynn, Commissioner of Crown Lands for a few remarks.

HON. E. J. FLYNN—I must thank you very kindly for the very hearty welcome you were good enough to extend to me on entering the room to-night to witness your good work. I am pleased indeed to have this opportunity and I must congratulate you. I feel that I am in the best of company here, in the company of gentlemen that are imparting practical knowledge and I put myself in the category of those who are acquiring knowledge. Of course I am a public man and I must say I have not got much time to acquire that very useful knowledge, but it is my duty as a member of the Administration to encourage as much as possible this good work. It has given me great pleasure to note the progress of the good work that is being accomplished by your Association. You have just heard of the mica mines on the lower shore of the St. Lawrence, and I can fully corroborate the statements made by Mr. Obalski, having received from other sources ample confirmation of the extent and value of these mica deposits. I would like to see a greater number invest capital in these mica mines. You will pardon me if I refrain from any further remarks at this time as I hope to be with you again to-morrow. It has given me great pleasure to have made your acquaintance and I congratulate you with all my heart upon the good work you are doing. Allow me to thank you again. (Loud applause.)

MR. B. T. A. BELL—I am sure every member of the Association appreciates to the full the trouble the Hon. the Commissioner of Crown Lands has taken to be present at this meeting and the pleasure his company has given us. His presence among us may be taken as a sure indication that the Government is disposed to meet us fairly and o do everything in its power to promote the development of the mining industry of this province. We must not forget also that i. is to the Hon. Mr. Flynn we are indebted for the complete repeal of the Mercier Mining Act. (Applause.)

After a vote of thanks to Messrs. Smith, Carlyle and Obalski for their papers, the meeting adjourned until Thursday afternoon.

MEETING ON THURSDAY.

The members reassembled in the club room on Thursday afternoon at three o'clock. There was again a large attendance. Owing to the absence of the president, who had to leave town, Mr. George E. Drummond, Vice-President, occupied the chair.

Visit of Belgian and other Experts.

MR. B. T. A. BELL.—Before proceeding with the business of the meeting I desire to make a statement respecting a motion that was submitted yesterday by Mr. Leofred. We were told that the Belgian, French and other foreign governments had determined to appoint a commission to enquire into the mineral resources of the Dominion and we were asked to endorse it. We passed a resolution to that effect. Since then, however, it has transpired that the proposition is simply being promoted by certain individuals to obtain large sums of money from the Dominion and Provincial Governments to *invite and defray* the expenses of a commission which is to spend a number of years in this country in the work of acquiring knowledge, and, as it would seem to be largely of the nature of an individual enterprise, I think that as an association we are unanimous in our desire to withdraw any countenance that may have been granted to such a scheme. There could be no objection in asking the Government to co-operate with a commission that was being sent here by any country, but as this bears on its face a strong suspicion of a scheme to put money in the pockets of the promoters, I desire to move that we erase from our minutes the resolution adopted entirely under a misapprehension at yesterday's meeting.

MR. T. J. DRUMMOND—I have much pleasure in seconding the motion. From what we have learned the matter is one which this Association cannot countenance. We were certainly misled by Mr. Leofred's statement that these foreign governments were to send such a commission at their own expense.

MR. B. T. A. BELL—I distinctly asked Mr. Leofred the question when he submitted his motion and I think it was adopted purely on his assurance that the foreign governments were sending the experts at their own expense. Personally, so far as I can gather, the whole affair is a pretty healthy scheme to put money in the pockets of the promoters.

MR. T. J. DRUMMOND—Our Government can aid the mining industry much better by advertising the resources of this country in more legitimate ways than this.

MR. F. CIRKEL—I certainly never heard of the German Government making any such proposition. If it had I should have heard or read of it in the German papers.

THE CHAIRMAN—The motion was passed, as Mr. Bell says, entirely under misapprehension. Is it the sense of the meeting that it be rescinded?

The motion was then put and carried unanimously.

On the Igneous Origin of Certain Ore Deposits.

BY DR. FRANK D. ADAMS, McGill University, Montreal.

The numerous and elaborate investigations into the nature and origin of ore deposits which have been carried out in recent years have led to the somewhat startling conclusion that certain of the deposits in question are of igneous origin. In stating that they are of igneous origin it is not meant merely that heat was in some way connected with their genesis, but that using the term as it is employed by geologists, that these deposits have cooled down and solidified from a molten condition like the other igneous rocks with which they are associated. The most important investigations into this class of ore deposits are those of Professor J. H. L. Vogt, of the University of Christiania, the results of these, however, having been published principally in the Swedish language are not so well known as they deserve to be, and as a valuable resume of his investigations has just been given by Prof. Vogt in the Zeitschrift Für Praktische Geologie, (numbers 1, 4 and 7, 1893) it has been thought that a brief presentation of the facts known concerning these deposits might be appropriately brought before the Mining Association at this time, especially in view of the fact that although this class is a comparatively small class of ore deposits it seems to be one especially well represented in Canada.

In order to present this subject in as clear a manner as possible, it will be advisable first to say a few words on some recent investigations into the nature of igneous rocks in general and the processes at work during the cooling of molten magmas, by the solidification of which igneous rocks are produced.

Recent researches have shown more and more clearly that a fused mass of rock is very similar to any ordinary solution of salt or sugar in water or any other solvent. As the fused mass slowly cools one mineral after another crystallizes out, a definite order being always observed. The mineral containing the largest amount of base, such as iron, lime or magnesia first separates out, then a series of other minerals containing less base, until finally there remains only a comparatively acid portion of the magma which may be considered as the solvent of the others, corresponding to the water of the saline solution above mentioned, which solvent may eventually crystallize itself. Thus for example in the case of a granite, we find that the various ores, magnetite, titanic, iron ore, pyrite, etc., first separate out, then the mica or hornblende, then the feldspars and finally the quartz. The ores together with the mica and hornblende may thus be considered as having been originally held in solution in the molten feldspars and quartz. Now it is known as the result of elaborate experiments on various saline solutions, that if a solution of any salt be heated and allowed to cool gradually the salt tends to concentrate in the cooler portions of the solution. It is also found that in concentrated saline solutions there is a certain tendency for the lower part of the fluid to become richer in salt than the upper portion, that is for the salt to settle down toward the bottom. In the case of certain alloys also, as is well known, it is often impossible to obtain a homogeneous mass on casting owing to the persistent way in which certain constituents of the alloy will concentrate toward the top or bottom of the bar or casting during cooling. Even in pig iron it is found that the amount of sulphur and phosphorus will vary considerably in the different portions of the same pig for similar reasons. This phenomenon in the case of alloys has long been known as liquidation.

In molten rock also a similar tendency to separate into portions differing in composition is clearly shown to exist by our geological studies of erruptive magmas, this tendency resulting in the separation of certain more basic parts of the magma from others which are less basic—that is to say the dissolved or basic material concentrates in certain places and this gives rise to a lack of uniformity in the mass—part of it being richer in certain minerals than other parts. In all probability differential cooling and the action of gravity are not the only factors which tend to bring about these remarkable phenomena in rocks, many other factors some of which we do not even suspect as yet, probably also working in the same direction. But whatever the causes may eventually prove to be which are most potent in bringing about these remarkable irregularities in molten rock masses, the fact remains that in cooling such masses do fall apart into portions differing in composition.

Now it stands to reason that since these changes are brought about by movements in the molten mass, the more fluid the mass is, the more favorable will be the conditions for such irregularities to develop themselves, and hence as basic magmas both naturally and artificially are more fluid than acid magmas, it is in basic magmas that such irregularities will be most strikingly seen. As actual examples of this process we may take for instance the basic borders which we find in connection with so many granite masses, where during cooling the more basic part of the magma has concentrated itself toward the sides of the mass. The dark spots and patches which disfigure so many granites are in many cases at least, portions of such basic parts which have been separated by subsequent movements in the magma. As a granite where this is excellently seen the Garabal Hill granite of Scotch highlands may be cited, or the celebrated Brocken massif of the Harz Mountains, in which a gradual passage from granite to gabbro can be clearly traced. Many similar examples nearer home might be cited, as for instance the igneous core of Mount Royal and many of its associated dykes in which remarkable variations of composition may be observed.

It is a universally recognized fact that ore deposits usually occur in connection with igneous rocks, that is with rocks which have solidified from a molten condition. Of these ore deposits however, two classes have as Prof. Vogt points out, a particularly intimate relation to such rocks, namely:

1st. Titanic iron ores.
2nd. Sulphide ores containing nickel.

These deposits not only occur in connection with the igneous rock but actually appear to form part of it, the ore occurring distributed through the rock and the heavy bodies of ore, merging gradually into it in many places, so that it is impossible to tell where the rock begins and the ore body ends. The ore body in fact seems to be merely a portion of the igneous mass in which the ore, which is one constituent of the normal rock, is concentrated sufficiently to form workable deposits.

Titanic Iron Ores.—One of the most celebrated deposits of this class is that occurring at Taberg in Smaland, in Sweden, and which has long been recognized as merely a local variety of the great intrusive mass of rock belonging to the Gabbro family and known in Sweden as olivine hyperite. This rock, which is poor in iron ore, can be observed step by step to pass over into the ore body, which has been extensively worked and consists of a mixture of titaniferous iron ore and olivine, the ore forming about 50 per cent. of the rock.

A sketch of this occurrence taken from Prof. Vogt's paper and showing the concentration of the iron ore in the central portion of the mass is given in Figure 1.

Another large deposit of iron ore at Cumberland, Rhode Island, occurs in a presisely similar manner as part of a gabbro mass and was for years extensively worked, but had to be finally abandoned on account of the large amount of titanic acid which it contained. In Brazil, Derby has also described the occurrence of large bodies of iron ore which gradually pass over into a mass of pyroxenite, of which they form part. Similar deposits of titaniferous iron ore of large extent have recently been recognized by Winchel in Minnesota, and by Kemp in the Adirondacks. In the latter case where the body of iron ore is about 20 feet in thickness, the great mass of gabbro of which it forms a part is closely related in petrographical character and probably in age, to the great areas of gabbro of anorthosite which in Canada occur in a number of places in our Laurentian country, occupying in some places hundreds, and in other places thousands of square miles.

These Canadian rocks also contain in many places large deposits of iron ore which are invariably rich in titanic acid, a fact which has made itself very patent in the failure which has followed all attempts to work them. Of these one of the best known is the great body of titanic iron ore near Baie St. Paul on the Lower St. Lawrence, where, in a great of mass of gabbro or anorthosite solid bodies of the iron ore 90 feet in thickness occur which have been traced for a mile or more. An attempt to work this made years ago, resulted in the loss of about £80,000 sterling. Other deposits of considerable size are known in the district north of Montreal, near St. Hypolite and St. Julienne, as well as at several other points in the so-called Norian gabbro area. In these as before the iron ore occurs as a constituent of the gabbro but is locally concentrated so as to be very abundant at these points. Another extensive deposit, although less widely known occurs on the River Saguenay, between Chicoutimi and Lake St. John. Here on the north shore of the river there is a group of hills composed of the titanic iron ore which occurs in another great gabbro mass having an area of not less than 5,800 square miles. This iron ore, which is also titaniferous, occurs principally in three bands, the most easterly of which is about 75 yards wide. The accompanying view has been reproduced from a photograph of this hill taken from near the shore of the Saguenay. It is thus evident that we have in these great deposits of titaniferous iron ore, true eruptive or igneous masses which are merely local and extremely basic varieties of the gabbro in which they occur, due to the concentration in certain parts of the mass, from some of the cases before mentioned of the most basic constituents of the rock. It will also be seen that these peculiar deposits are not confined to one locality, but are found under similar conditions in widely separated parts of the world.

When it is once recognized that these deposits have the origin here described a solution is afforded to what has hitherto been a puzzling fact, namely, that all the iron ores occurring in the so-called Norian series in the Laurentians, which is composed exclusively of eruptive anorthosite or gabbro, are rich in titanic acid, while in the same district deposits of magnetite free from titanic acid will be found in the associated gneisses.

Vogt notices that, in the cases which he mentions, these iron ores occur toward the central portions of the igneous masses rather than toward their margins, while in the case of the sulphide ores forming the other class of these deposits the reverse is the case. This does not however, appear to be by any means invariably the case in the similar deposits of titanic iron ore in Canada.

The igneous origin of many of these deposits of titaniferous iron ore has long been recognised, but Prof. Vogt proceeds to show that certain great deposits of sulphide ores have in all probability a similar origin.

SULPHIDE ORES CONTAINING NICKEL.

He first shows that the nickel ores of the world fall into three principal classes.

1. Ores containing arsenic and antimony, with or without bismuth.
2. Sulphureted ores without arsenic, that is to say, nickeliferous pyrhotite or pyrite, millerite, polydymite, etc.
3. Silicated nickel ores.

Of these, No. 1 occur principally in veins, as for instance in various places in Saxony and at Mine Lamotte and Bonne Terre in Montana.

No 2, which is the class of which this paper treats, occur in basic intrusive rocks being apparently formed by a differentiation of the magmas and local concentration of the ore. Of these the celebrated Norwegian deposits as well as those of Varallo in Italy and of Sudbury in Canada are examples.

No 3, occur as veins in serpentine, which results from the alteration of basic eruptive rocks, the ore being leached out during the process of decomposition and accumulated in the veins by lateral secretion as in the case of the great nickel deposits of New Caledonia, which are now the principal competitors of our Canadian nickel deposits.

Dismissing the first and third classes of deposits as having quite a different origin and confining our attention to the second class, the first striking fact to be noticed concerning them is that they are so simple and uniform in character in all parts of the world that a mineralogical description of one set of deposits would serve for all. The principal minerals which they contain are pyrrhotite or magnetic iron pyrites, a sulphide of iron which almost invariably holds a little nickel and cobalt, but which in these deposits usually contain 2 to 5 per cent. of these metals. Pyrite containing nickel and cobalt is also present, usually in smaller amount than the pyrrhotite, and having a better crystalline form owing to the fact that it is crystallized at first. This mineral usually contains proportionately more cobalt and less nickel than the pyrrhotite. With these in a few deposits minerals richer in nickel have been observed, three of these have been certainly recognised and possibly others may be yet discovered. Of these pentlandite (Fe, Ni) S has been recognised at two Norwegian localities and in considerable quantities by Mr. D. H. Browne, at the Copper Cliff and Evans mines and at the Worthington mine, in the Sudbury district. (*Eng. and Min. Jour.*, Dec. 2nd, 1893). Polydymite (Ni_3 Fe S_5) occurs at the Vermillion mine in the Sudbury district, while Millerite also occurs in certain of the Sudbury deposits, as well as at the Lancaster Gap mine in Pennsylvania. Copper, pyrite, usually present in considerable amount, and titanic iron ore, complete the simple list of minerals found in these deposits. Other metallic minerals are present only as the rarest exceptions and in very small amount, among these the most noteworthy being sperrylite, an arsenide of platinum (Pt Ao_2), discovered in the ore of the Vermillion mine above mentioned and not known to occur anywhere else in the world.

This remarkable group of ores therefore contains nickel, cobalt, copper and iron, united with sulphur and some titanic acid, while lead, zinc, silver, arsenic, antimony, bismuth and tin are absent or occur only in traces. Moreover, a remarkable fact in connection with this class of deposits is that—as Prof. Vogt shows—if the average of large quantities of ore such as the output of a mine be taken, there is a certain ratio between the richness of the pyrrhotite in nickel and the per centage of copper contained in the deposit. Thus in the Norwegian deposits he states that in those workings which produce an ore containing from 75 to 80 parts of copper to 100 parts of nickel and cobalt, the pure pyrrhotite holds about 2.5 per cent. of nickel and cobalt, while as the copper sinks the per cent. of nickel and cobalt in the pyrrhotite rises until when but 20 to 25 parts of copper to 100 parts of nickel and cobalt are present in the ore, the pyrrhotites holds over 7 per cent. of the latter metals.

NOTE.—The illustrations in Dr. Adams' and Prof. Carlyle's papers were not completed in time for puplication.

this connection a recent statement by Mr. D. H. Brown (*loc. cit.*) is of interest, namely that in the case of the Copper Cliff Mine, which, as the name indicates, was opened up and worked for copper before the ore was known to contain any nickel, on sinking, a decrease in the amount of copper has been followed by an increase in the richness of the pyrrhotite in nickel, the very large body of ore struck in the 7th level and which is almost entirely free from copper pyrites, consisting of a pyrrhotite averaging about 10 per cent. of nickel.

The following table will show this relation in the case of a number of the Scandinavian deposits and it would be a matter of great interest if it could be ascertained that a similar relation exists in the case of our Canadian deposits. As Prof. Vogt points out, in order to obtain averages for large deposits, it is best to draw the results from the analyses of the mattes obtained by smelting the ores of the several deposits, copper and nickel being concentrated in almost exactly the same proportion. It has been found in the case of the Scandinavian deposits that although the proportion between pyrrhotite and copper pyrite may vary considerably from day to day, the average for a considerable run is pretty constant.

RATIO OF NICKEL TO COPPER IN SOME OF THE MOST IMPORTANT NORWEGIAN AND SWEDISH MINES.

Name of mine.	Content of copper corresponding to 100 parts of nickel.	Percentage of nickel and cobalt in the pure pyrrhotite.
Graagalten mine..	75–80	About 2·5
Klefra mine	55	" 2·75–3·0
Erteli mine.......	45–50	" 3·0
Bamle district.....	35–40	" 3·5 –4·0
Flaad mine.......	37	" 4·5
Senjen mine	35–40 (about)	" 3·5 –4·0
Dyrhang mine....	30–35	" 3·8 –4·2
Beiern mine......	20–25 (about)	" 7·0

Prof. Vogt also draws attention to the fact that the average proportion of nickel to copper in the Norwegian ores is about 100 to 40 or 50, and that in the Piedmontese occurrences about the same proportion holds good, while in Canada where the associated igneous rocks are of a somewhat different character, there is often relatively more copper, 100 parts nickel to 100 or even 150 of copper being found in some deposits, while in others the ordinary Norwegian proportion still holds good.

In Norway there are some 40 gabbro masses with which deposits of nickeliferous pyrrhotite are associated, these being the largest nickel deposits in Europe. The gabbro, which is undoubtedly an igneous rock, is composed of plagioclase, feldspar and a rhombic pyroxene, thus belonging to the variety of gabbro known as Norite. These masses of gabbro occur in the Archean schists, generally intruded between the layers or beds but often cutting across them. The Norite of all the masses shows a remarkable tendency to differentiation so that one and the same mass, in different parts of its extent, will vary greatly in relative proportion of the constituent minerals.

The pyrrhotite, pyrite and copper pyrite are regular constituents of the Norite occurring in small quantities all through the various masses but like the other constituents being found more abundantly in certain places, so that a gradual passage can often be observed from the normal Norite through a pyrrhotite Norite to masses of pure ore. Sometimes on the other hand the ore occurs in masses sharply separated from the Norite. These segregations of ore are in the great majority of cases situated at or near the edge of the Norite masses and Vogt regards them as strictly comparable to the basic borders or edges so often observed about granites and other igneous rocks as before mentioned, in which the basic portions are sometimes marked by similar gradual passages and in some cases by sharp transitions. These sharp transitions are easily explicable when one considers that any part of the magma having once separated itself from the rest, being possessed of a decidedly different specific gravity and perhaps of a different degree of fluidity, would, if the whole mass were caused to move, keep itself separated by a comparatively sharp line from the rest of the molten mass.

Furthermore Vogt states—and this is a point which has a very practical bearing with those who are interested in our deposits—that in Norway although it is of course impossible to establish a mathematical ratio between the area of the gabbro mass and the quantity of ore in the associated ore deposits, nevertheless experience has shown that the deposits associated with the small gabbro masses are always unimportant and that all the larger ore bodies are found in connection with the larger gabbro areas, as might be expected if his explanation of the origin of the ore is a correct one.

The nickel deposits of Varallo in Piedmont, Italy, which were worked from 1860 to 1870, are very similar in almost every respect to those just described from Norway, occurring like them in Norite near the contact with the country rocks. A similar association of nickeliferous pyrrhotite with a rock of the gabbro family also occurs at the Lancashire gap mine in Pennsylvania and at Schweiderich in Bohemia.

The great nickel bearing sulphide deposits of the Sudbury district—the largest and most important deposits of this kind known to exist—in mineralogical composition and mode of occurrence are remarkably similar to those just described in the several localities above mentioned.

The work of Mr. Barlow and Dr. Bell of the Geological Survey in the Sudbury district and the excellent geological map of the district which they have prepared present these remarkable resemblances in a striking manner. As in Norway, there are here a large number of igneous masses—some 60 in the 3,500 square miles embraced by the geological map above mentioned—composed of a rock which although it has been commonly called diorite, has proved in most of the cases where it has been carefully examined to be a gabbro more or less altered with the development of secondary hornblende, that is to say substantially the same rock as in Norway and elsewhere. These diorites cut through the clastic rocks of Huronian age, to whose strike they in most cases conform in a general way, but like these latter are in places cut by granites of later age. The ore, as has been mentioned, is a nickeliferous pyrrhotite associated in some cases with polydymite, pentlandite or millerite and mixed with copper pyrite. It occurs disseminated through this gabbro or diorite, sometimes in sufficient abundance to form deposits which can be worked, the large workable deposits usually being formed by a concentration of these ores near the edges of the gabbro masses or at the contact of these with the Huronian rocks or with the granites, but never extending into these to any considerable distance from the gabbro.

Such deposits have no well defined wall but merge into the gabbro, the wall so far as the miner is concerned being the limit of profitable working due to the fading away of the ore body into the gabbro, so that in underground work an abundant sprinkling of ore through the gabbro serves as an indication of the proximity of heavy ore bodies.

Furthermore, as in Norway, there seems to be in these deposits a certain relation between the size of the deposit and the area of the gabbro mass in which it occurs, since all the extensive mining operations are carried on in deposits associated with large gabbro masses, while in connection with many of the smaller masses, smaller deposits as yet unworked and in many cases unworkable are known to exist. It is also, as has been mentioned, not unlikely that a relation between the percentage of nickel in the pyrrhotite and the amount of copper present in the several deposits similar to that which has been noted in the Norwegian deposits may exist in these Canadian deposits as well. In fact these Canadian deposits resemble those of Norway and all others of the class having similar geological relations wherever they occur throughout the world, in a most remarkable manner, the points of resemblance being so numerous and so striking as to preclude mere chance coincidence.

The facts in the case of these Sudbury deposits point to these also having originated in the elements of the pyrrhotite and copper pyrite, originally disseminated through the molten rocks, having during the process of cooling seggregated themselves together in certain parts of the magma, especially toward the sides, just as certain other constituents have a tendency to do in igneous rocks of various kinds, especially in basic rocks such as these gabbro, and even in these very gabbro masses themselves.

This presented itself to Mr. Barlow, who has made the most careful study of these deposits as the only tenable view concerning their origin, even before Prof. Vogt published the result of his elaborate studies in Norway. "The ores and associated rock" Mr. Barlow writes," were in all probability simultaneously introduced in a molten condition, the patches of pyritous matter aggregating themselves together in obedience to the law of mutual attraction." (Ann. Rep. Div. of Mineral Statistics, Geological Survey of Canada, 1889-90, p. 128.) One fact in the case of the Canadian deposits which might at first sight seem to oppose this view of their origin, is the frequent occurrence of the ore along or near the contact of the diorite with granite, which judging from contact phenomena, is more recent than the diorite and consequently would have been intruded after the ore deposits were formed and consequently cannot be considered as the wall rock of the molten diorite toward which the seggregation would take place. But it must be remembered that in such a district of hard and massive diorites and softer stratified rocks, any shattering which would precede the intrusions of the granite would probably tend to develop lines of fracture along the contact of these two rocks and thus afford a ready passage for the granite magma in these directions. The contact of the diorite and the granite would thus mark approximately, in many cases at least, the contact of the diorite with the Huronian rocks through which it was intruded.

Concerning these sulphide ores containing nickel therefore, Prof. Vogt sums up as follows:—

1. These deposits, which are numerous and occur in widely separated countries, are always found in connection with some basic igneous rock allied to gabbro and since this is invariably the case we must conclude that the deposits stand in some genetic relation to this igneous rock.

2. Since we can frequently trace a gradual passage from the workable deposits into the igneous rock by a progressive increase in the amount of ore in the rock, we must conclude that the ore masses were not in any way introduced into the rock subsequent to cooling but were separated out of the molten magma during the solidification of the rock. This conclusion is also borne out by the remarkable simplicity and uniformity of chemical and mineralogical composition of these deposits throughout the world, by the relation between the size of the ore deposit and the area of the gabbro mass in which it occurs, as well as by the absence in these deposits of lead, zinc, arsenic, antimony, bismuth, etc., and of those minerals which are especially characteristic of the so called pneumatolitic action.

3. Owing to the fact that, as Fournet has shown, the metals copper, nickel, cobalt, iron, tin, zinc, lead, silver, antimony and arsenic have in general a decreasing affinity for sulphur in the order named, the small percentage of copper, nickel and cobalt present in the original magma united with sulphur and becomes thus concentrated in any sulphide of iron which separates, while any tin, zinc, lead, silver, antimony or arsenic present in the magma is not so concentrated.

4. From what we know of the amount of copper, nickel and cobalt contained in these rocks themselves we are justified in concluding that these metals are always present in the original magma in amount quite sufficient to supply material for all the deposits in question, if only the concentration can be effected, and in this connection it would also follow that there must be a certain ratio between the size of the eruptive mass and the extent of the ore deposit.

5. The copper of the deposit always appears as copper pyrite. The nickel becomes concentrated in pyrrhotite or appears in the form of millerite, pentlandite, or polydymite, all minerals comparatively poor in sulphur, while the cobalt on the other hand is concentrated in the pyrite which is much richer in sulphur.

6. In the Canadian nickel bearing sulphide deposits, platinum in the form of sperrylite is sometimes found, which would seem to be analogous to the occurrence of native platinum and osmiridium metals, contained in the more or less serpentinized, basic olivine bearing rocks in the Urals and elsewhere to be mentioned further on.

7. Titaniferous magnetite or Ilminite almost always occurs in small amount in the nickel bearing sulphide deposits, indicating a genetic relation and to a certain extent a transition between these sulphide secretions and the deposits of titaniferous iron ore mentioned in the beginning of this paper as having a similar origin.

8. The nickel bearing sulphide deposits occur in almost all cases about the edges of their several igneous masses, a fact which, as has been mentioned, is susceptible of explanation in that the sulphides, following Soret's principal, become concentrated toward the cooling surfaces of the mass.

Another remarkable fact tending to the same conclusion and showing the importance of geological studies in connection with ore deposits, is that although in the several widely separated countries the pyrrhotite deposits associated in the manner above described with the gabbros are so rich in nickel, the celebrated Fahlbands of Norway which are bedded or apparently bedded deposits consisting of heavy impregnations of pyrrhotite, pyrite, copper pyrites, etc., but occurring in gneisses or schists of various kinds contain hardly any nickel, hundreds of analyses showing the nickel and cobalt contents to range from .25 to .50 of one per cent., and what is still more remarkable the same is true of the similar Fahlbands so often associated with our Laurentian limestones in Canada, so far as these have been examined. In these the pyrrhotite and pyrite is present in large amount and is often associated with copper pyrite but only a very small quantity of nickel and cobalt, usually not amounting to more than a trace, is present. (Adams, Frank D., Preliminary Report on the Geology of Central Ontario, Geological Survey of Canada, 1894, in press.)

METALLIC SEGGREGATIONS FROM IGNEOUS ROCKS.

Some few cases of the seggregntion of metals in a free state are known to occur in igneous rocks. These deserve much more careful and extensive study than has yet been bestowed on them in view of the light which they promise to throw on the origin of ore deposits such as these which have just been considered.

These are of two classes:

1st. Iron-nickel alloys.

2nd. Platinum and osmiridium metals.

The celebrated occurrences of native iron holding about 2 per cent. of nickel, discovered by Nordenskjold in basalt and at Uifak and Assuk in Greenland, are now believed to have resulted in the reducing action of the carbonaceous material in the rock through which the basalt was erupted, but these occurrences nevertheless afford an example of the concentration of nickel, which must originally have been disseminated in small amount throughout the molten basalt, in the iron which has been reduced in the way above described, a more recently noted and even more remarkable occurrence is the Awaruite of New Zealand which is composed of 67·93 per cent. of nickel, ·70 per cent. of cobalt and 31·02 per cent. of iron and is found in a very basic igneous rock belonging to the class Peridotites. (G. H. F. Vlrich, Quart. Jour. Geol. Soc., Nov., 1890.)

In the various parts of the world where platinum occurs in alluvial sands it has been found from time to time intimately associated with serpentine and chromic iron ore, thus indicating as its probable source some Peroditite or Olivine rock, and Murtchison long ago mentioned its occurrence in the serpentine rocks of the Urals. ("Russia in Europe," p. 484.) Some ten years ago, however, this probability became a certainty for on the western slope of the Ural mountains platinum was found in grains disseminated through an olivine gabbro, which there formed the bed rock on which the platinum bearing gravels rest. Recently, at a locality on the eastern slope of the same mountain chain platinum associated with chromic iron ore has been found so abundantly disseminated through an olivine rock that this latter can be actually worked with profit, as much as 93 to 110 grains of platinum to the ton of rock being found. (R. Helmhacker, Zeit. Fürprak, Geol. Feb., 1893, and Can. Record of Science, April,

1893. *See also* Eng. and Mining Journal, Dec. 22, 1893.)

It is thus evident that the platinum of commerce also occurs originally as a seggregation from basic igneous rocks.

The uniform character and constant association of chromic iron ore wherever deposits of this mineral are found with serpentine, which rock is a decomposition product of basic eruptive rocks rich in olivine, points very strongly to the probability of this mineral also being a product of the differentiation of basic igneous magmas during cooling, but its solidification and alteration to serpentine. Our knowledge of these deposits, however, is not as yet sufficiently extensive, nor sufficiently exact to enable any definite conclusions to be reached on this most interesting subject.

Although therefore these mineral deposits which present evidence of having originated in the differentiation of igneous masses during cooling, form a comparatively small class of deposits, they are full of interest, especially for us in Canada where so many of these deposits occur, and this brief presentation of some of the principal facts concerning them has been given in the hope that the Mining Engineers of our Dominion, many of whom are engaged in the working deposits of this class, having these facts in view may be induced to make a careful study of these deposits with a view of extending or perhaps correcting our knowledge concerning them.

The Manufacture of Iron and the Canadian Iron Industry—A Plea for Protection.

By Mr GEORGE E. DRUMMOND, Montreal.

"There is a tide in the affairs of men,
Which, taken at the flood, leads on to fortune.
Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves
Or lose our ventures."

These lines apply with peculiar force to Canada, in the present stage of her iron industry.

Events are transpiring from day to day in the neighboring Republic, which demonstrate that the iron industry of that great country has now reached such magnificent proportions, under the wise protective policy so well maintained for the past forty years, that American iron masters are able to compete on equal terms with the world.

History repeats itself. As with England at the middle of this century, so now with the United States. Her iron industry has reached that stage when the Government of the country can consider the question of a reduction in its protective tariff, with comparative safety to the industry itself.

Here in Canada, the iron industry, still in the pioneer stage, although under Government encouragement showing an increase in actual output of nearly 100% in the past two years, broadening out day by day, making a place for itself in the home market, and in the face of many difficulties, displacing gradually the products of American and British furnaces, finds itself at the most critical stage of its existence, threatened by a premature demand for a reduction in the current protective duties, which, if acceded to by the Government, will surely prevent further progress, if indeed it does not altogether annihilate the industry, by exposing it before it is yet established, to the hostile competition of foreign producers, particularly to the competition of American furnacemen, who have of late been the chief, if not the only competitors for our most important territory, viz. the markets of Western Canada.

To produce pig iron, the basis of all subsequent stages of the iron industry, a very heavy initial expenditure has to be made in the prospecting, securing, and development of mines, woodlands, limestone quarries, railways, shipping docks, etc., necessary to ensure a constant supply of raw material

The establishment of the plant itself demands a heavier outlay, in proportion to the value of the product, than is required for the production of any other staple. It is the experience of almost every iron master, that in the early period of iron making, in all countries, the work is more or less of an experimental nature, and as it must be carried on upon a large scale, and if unsuccessful the investment becomes worthless, the risk of ruin to the first adventurers is great.

It has necessarily resulted from these causes, that to start an iron industry on an important scale, in any country, however favorable its apparent natural conditions, State aid, either by direct bounty, by a heavy protective duty, or by both combined, has been found necessary, and it is in those countries where this has been *effectually done*, which are to-day the large producers of iron, not only supplying their own wants, but also those of other countries.

To deal with this question intelligently, it is well for Canadians to review, as briefly as the importance of the issues will permit, the history of the establishment and successful development of the iron industry in other countries, and particularly note the broad liberal policy of protection under which Great Britain and the United States alike built up the greatest and most successful iron industries of modern times.

The importance of the issues will perhaps in some measure excuse the lengthy references to the methods adopted by our competitors to bring about the successful development of their iron industries, and some description of the splendid equipment they now possess in furnace plant, shipping docks, and other accessories necessary to economical working, will perhaps not be out of place.

John Stuart Mill says: "To draw inferences is the great business of life."

In the light of what has been accomplished by wise administration in other countries, particularly in Great Britain and the United States, Canada may be guided as to the best and surest course for an early development of the great mineral wealth with which God has blessed her.

Iron is perhaps the Almighty's greatest metallurgical gift to man Its use can be traced to the very earliest ages. Biblical and secular history abound with mention of the use of iron by the forerunners of our race. Tubal-Cain, born in the seventh generation from Adam, is described in the IV. Chapter of Genesis as "an instructor of every artifice in brass and iron."

In the time of Moses, the Egyptians seem to have been engaged in the manufacture of iron, as referred to in the IV. Chapter of Deuteronomy, 20th verse. "But the Lord hath taken you and brought you forth out of the iron furnace, even out of Egypt." This expression again occurs in I. Kings, 8 and 51.

Swank, in his admirable "Iron in all Ages," says.—"The Egyptians, whose existence as a nation probably dates from the second generation after Noah, and whose civilization is the most ancient of which we have any knowledge, were at an early period familiar with the use and manufacture of iron. Iron tools are mentioned by Herodotus as having been used in the construction of the pyramids. In the sepulchres of Thebes and Memphis, cities of such great antiquity that their origin is lost, butchers are represented as using tools which antiquarians decided had been made of iron and steel. Iron sickles are also pictured in the tombs of Memphis and Thebes, and various articles of iron have been found, which are preserved by the New York Historical Society, and are probably three thousand years old.

Herodotus in the fifth century before Christ speaks of the Chalybians as "a people of iron workers."

The Persians and their northern neighbors the Medes, made iron and steel long before the Christian era, and so did the Parthians and other Cythian tribes.

Ages ago Damascus, the capital of Syria, manufactured its famous swords from Indian and Persian steel.

It may be assumed as suspectible of abundant proof that the knowledge of iron, if not of its manufacture, was common to the people of Africa long previous to the Christian era The decay of the iron industry of these ancient countries probably contributed towards the ruin of the empires of the east, and as Swank says: "With the fading away of Asiatic and African civilization and magnificence the manufacture and use of iron in Asia and Africa ceased to advance."

Following the march of civilization, the iron industry took root in the west, and has contributed in a very great measure to the wealth of the two most powerful industrial nations of modern times, Great Britain and the United States.

Great Britain The history of the British iron industry dates back to the days of the Roman occupation, as evidenced by the fact that in Kent, Sussex, Gloucester, Yorkshire, and many other parts of England large quantities of iron cinder, as old as the Roman era, have been discovered. This has been further proved by the finding of Roman coins, pottery and altars in connection with the cinder

From the days of the Romans down to the middle of the 17th Century, the furnaces and forges of England were operated altogether with charcoal as a fuel. Aided by the protection to native iron inaugurated by Edward III during his reign from 1327 to 1377, the iron industry made very good progress.

In the 14th Century, the ironsmiths of England had brought the trade to a fine art, aiding thereby to establish the present industrial pre-eminence of England; locks, keys, hinges and bolts, produced during that period having never since been equalled in beauty of design.

In 1615 it is said that there were 800 furnaces, forges, or other mills making iron with charcoal, of which Dudley a few years later estimated that about 300 were furnaces, the weekly product of which was about 15 tons each.

The charcoal iron industry seems to have reached its height towards the close of the reign of Elizabeth, when the trade became so prosperous that instead of importing iron as she had hitherto done, England began to export it in considerable quantities, in the shape of iron ordnance. The extent of the operations however, began to exhaust the forests of England about the beginning of the 17th century, and the British Parliament had to give its serious attention to the question.

In 1740 the production of pig iron in Great Britain was only 17,350 tons, her iron industry at this time having been almost destroyed by the decreasing supply of charcoal.

About 1750 mineral coal, in its natural state or in the form of coke, came into notice as a substitute for charcoal. The iron trade of England and Wales at once revived, while that of Scotland may be said to have been actually created by this new fuel.

Great improvements were introduced in the furnace plants of Great Britain, and the industry from that date forward advanced steadily.

In 1787 the British Government adopted a strong protective tariff for their iron industries, the duty on pig iron being placed in that year at 67 2 per ton, with higher rates for manufactured iron. This duty on pig iron was later on increased in 1819, and again in 1825, and the protective tariff in this department was maintained down to the year 1845.

The effect of the introduction of mineral coal, and of the protective duties levied on foreign iron was most beneficial. The industry at once showed strength, and from that date continued to grow rapidly, until in 1796 there were 104 furnaces in England and Wales producing 108,793 tons of iron, and in Scotland 17 furnaces producing 16,086 tons.

In 1820 the total production had reached 400,000 tons, in 1825, 5[illegible],367 tons; in 1840, 1,396,400 tons; and in 1854, 3,069,838 tons; this quantity being then estimated as fully one-half of the world's production of pig iron.

In 1889 Great Britain's production of pig iron had reached 9,321,563 tons of 2,000 lbs. This with a population estimated at thirty-eight millions, gives the enormous production of 495 lbs. per head. Of this output Great Britain herself consumes 250 lbs. per capita.

In considering the progress made it is well to remember the various Acts of Parliament enforced from time to time by England to protect her national iron industry, by preventing the emigration of her skilled artisans to other countries, by guarding against the sale of her inventions to competitors, and by the imposition of Customs duties upon foreign products.

For instance while the growing scarcity of wood for the supply of charcoal convinced the Government and people of England as early as 1750, (before mineral fuel had come into use) that it would be to their advantage to allow the free admission of iron in its rudest form from the American colonies, and that as a matter of fact they passed an Act in that year setting forth that it would be of great advantage not only to the Colonies, but also to the Kingdom, that the manufacturers of England should be supplied with pig and bar iron from the Colonies free of duty, yet they so fully believed in protecting their own home industries, that the same Act that made the rudest forms of iron free of duty (because England was unable to produce the material herself) contained the following clause,—

"That pig and bar iron made in His Majesty's colonies in America *may be further manufactured in this kingdom*, be it further enacted........that from and after the twenty-fourth day of June, one thousand seven hundred and fifty, no mill or other engine for slitting or rolling of iron, or any plating forge to work with a tilt hammer, or any furnace for making steel, shall be erected, or after such erection continued in any of His Majesty's colonies in America, and if any person or persons shall erect or cause to be erected, or after such erection continue, or cause to be continued, in any of the said colonies, any such mill, engine, forge, or furnace, every person or persons so offending shall for every such mill, engine, forge, or furnace, forfeit the sum of two hundred pounds of lawful money of Great Britain, and it is hereby further enacted........that every such mill, engine, forge, so erected, or continued contrary to the directions of this Act, *shall be deemed a common nuisance, etc., etc.*"

By the Act in question Great Britain undoubtedly encouraged the production of pig and bar iron in America, by exempting them from duties to which like commodities were subject when imported from any other country, but she did this simply because she had not until that date found a fuel substitute for charcoal. A glance at the Act however, will moreover, show that she imposed an absolute prohibition upon the erection of steel furnaces and slit mills in any of her American colonies.

Various other restrictive Acts of Parliament were passed in 1781, 1782, 1785 and 1795, to prevent the the exportation to foreign countries of machinery and tools used in the manufacture of iron and steel, and to prevent skilled machinics from leaving England.

For example an Act in 1785, 25 Geo. III., c. 67.

"To prevent, under severe penalties, the enticing of artificers or workmen in the iron and steel manufactures out of the kingdom, and the exportation of any tools used in these branches to any place beyond the seas."

The penalty provided in this Act read,—

"If any person or persons shall contract with, entice, persuade, or endeavor to seduce, or encourage, any artificer or workman concerned or employed, or who shall have worked at, or been employed in the iron or steel manufactures in this kingdom, or in making or preparing any tools or utensils for such manufactory, to go out of Great Britain to any parts beyond the seas (except to Ireland) and shall be convicted thereof.........shall for every artificer so contracted with, enticed, persuaded, encouraged or seduced, or attempted so to be, forfeit and pay the sum of five hundred pounds of lawful money of Great Britain, and shall be committed to the common gaol........there to remain without bail or mainprize for the space of twelve calendar months, and until such forfeiture shall be paid, and in case of a subsequent offence of the same kind, the person or persons so again offending shall upon a like conviction, forfeit and pay for every person so contracted with, enticed, persuaded, encouraged or seduced, or attempted so to be, the sum of one thousand pounds.......... and shall be committed to the common gaol as aforesaid there to remain without bail or mainprize for and during the term of two years, and until such forfeiture shall be paid."

In addition to these restrictive measures, a glance at the protection afforded to the British manufacturers of iron from 1782 to the close of 1825, will demonstrate to Canadians the fact that England owes her greatness in the iron industry very largely indeed to the protection granted to her native industries in the early years of the trade.

Quoting from Scrivener's History of the Iron Trade:—

"From 1782 to 1795 the duty on foreign bars was £2 16s. 2d. per ton. It rose to £3 4s. 7d. in 1797. From 1798 to 1802 it was £3 15s. 5d. In two years it had got to £4 17s. 1d. and from 1806 to 1808 it stood at £5 7s. 5¾d. In the three years between 1809 and 1812 it was £5 9s. 10d.

and in the five years ending with 1818 it had been £6 9s. 10d.

"At this date a distinction was made in the interests of British shipping, for whilst thenceforward till the close of 1825 the duty on foreign bars was £6 10s. if imported in British ships, it was £7 18s. 6d. if imported in foreign. Nor was this all, iron slit, or hammered into rods, or iron drawn down, or hammered, less than three-quarters of an inch square, was made to pay a duty at the rate of £20 per ton, wrought iron, not otherwise enumerated, was taxed with a payment of £50 for every £100 worth imported, and steel, or manufactures of steel, were similarly loaded with a 50 per cent. duty."

Mr. James Mavor, the present professor of political science in the University of Toronto, quoting from Conrad's Handworterbuch der Staats Wissenchafter, vol. III, page 45, and also from various other authorities, gives the following data in regard to the duties imposed at various times by Great Britain in the interest of her iron industry.

"The duty imposed on pig iron in 1787 was 67 2 per ton. Duty increased 1819 to 130/ per ton on pig iron. Duty raised 1825 by 10/ per ton. Duty altered 1842, 25 per cent. *ad valorem* on pig iron. Duty abolished 1845.

"Duty on manufactured iron altered 1845, 15 per cent. on manufactured iron and steel, this subsequently reduced to 10 per cent. Duty on iron wholly abolished 1860."

Among other measures quoted by this authority are special rates for carrying coals to iron works, embodied in the earlier railway Acts.

The period of protection by high customs duties extended from 1787 until 1860, giving to the iron industry protection of a permanent character for upwards of 73 years.

The restrictive measures cited, although they were in many cases harsh, undoubtedly resulted in building up an industry of great value not only to Great Britain, but to the world at large.

United States—Great as has been the progress made in the iron industries of Great Britain, still more marvellous has been that of the United States, especially when we consider that the development of the American iron industry has been made very largely within the past forty years, and a full consideration of the facts will show that this rapid growth has been due almost altogether to the fact that during that forty years the Government of the United States has stood firmly by the policy of protection to the native industry, and that the greatest progress was undoubtedly made when the protection was at its highest point.

The first attempt to establish iron works in the United States was made in 1619, the works being located at Falling Creek, a tributary from the James River, in Virginia. This was unsuccessful, but during the 18th century Virginia became quite prominent in the manufacture of iron.

In 1643 an iron works was started in the Province of Massachusetts Bay, which claims to be the first successful iron works established in America. Several other forges were erected at various points throughout New England, in all cases the fuel used being charcoal.

In the State of New York the first iron works would seem to have been erected in 1740 on Ancrum Creek, Columbia county, close to the Hudson river. This furnace was contemporary with our own St. Maurice forge erected A.D. 1752.

In 1800 the celebrated Champlain iron district was developed and in 1801 the first iron works in the district were built. As in New England, so in New York and throughout the United States, charcoal was the only fuel used at this period.

New Jersey saw her first iron furnace in 1676, and Pennsylvania, the greatest producer of all the States, witnessed the inauguration of the iron industry under the able administration of William Penn in 1716, the iron produced by one Thomas Rutter Smith, who lived not far from Germantown, being said to have proved equal to the best Swede irons.

In 1728 there were four furnaces in blast in Pennsylvania and from that date forward the iron industry of the State was assured.

Space prevents a more minute description of the difficulties experienced and overcome by the pioneer furnacemen of the United States.

Coming down to more modern days, the following statistics, dated from 1854 to 1890, will serve to show the magnificent development of the American iron industry, under the protective tariff shown in the list.

PRODUCTION OF PIG IRON IN THE UNITED STATES FROM 1854 TO 1890.

Net tons of 2,000 pounds.

Calendar Year.	Anthracite & mixed anthracite and coke.	Charcoal.	Coke and raw bituminous.	Total.	Duty on pig iron of all kinds.
					per cent.
1854..	339,435	342,298	54,485	736,218	30
1855..	381,866	339,922	62,390	784,178	30
1856..	443,113	370,470	69,554	883,137	30
1857..	390,385	330,321	77,451	798,157	30
1858..	361,430	285,313	58,531	705,094	24
1859..	471,745	284,041	84,841	840,627	24
1860 .	519,211	278,331	122,228	919,770	24
1861..	409,229	195,278	127,037	731,544	24
					per ton.
1862..	470,315	186,660	130,687	787,662	$6 00
1863..	577,638	212,005	157,961	947,604	6 00
1864..	684,018	241,853	210,125	1135,996	6 00
1865..	479,558	262,342	189,682	931,582	9 00
					per ton.
1866..	749,367	332,580	268,396	1350,343	9 00
1867 .	798,638	344,341	318,647	1461,626	9 00
1868	893,000	370,000	340,000	1603,000	9 00
1869..	971,150	392,150	553,341	1916,641	9 00
1870	930,000	365,000	570,000	1865,000	9 00
1871	956,608	385,000	570,000	1911,608	7 00
1872	1369,812	500,587	984,159	2854,558	7 00
1873	1312,754	577,620	977,904	2868,278	6 30
1874	1202,144	576,557	910,712	2689,413	6 30
1875	908,046	410,990	947,545	2266,581	7 00
1876.	794,578	308,649	990,009	2093,236	7 00
1877	934,797	317,843	1061,945	2314,585	7 00
1878	1092,870	293,399	1191,092	2577,361	7 00
1879	1273,024	358,873	1438,978	3070,875	7 00
1880	1807,651	537,558	1950,205	4295,414	7 00
1881	1734,462	638,838	2268,264	4641,564	7 00
1882 .	2042,138	697,906	2438,078	5178,122	7 00
1883..	1885,596	571,726	2689,650	5146,972	7 00
1884 .	1586,453	458,418	2544,742	4589,613	6 27
1885.	1454,390	399,844	2675,635	4529,869	6 72
1886 .	2099,597	459,557	3806,174	6365,328	6 72
1887	2338,389	578,183	4270,635	7187,206	6 72
1888.	1925,729	598,789	4743,989	7268,507	6 72
1899 .	1920,354	644,300	5951,425	8516,079	6 72
1890	2448,781	703,522	7154,725	10307,028	6 72

In an able article, "From Mine to Furnace," Mr. John Birkinbine, Past President American Institute Mining Engineers, recently said:—

"The following remarks concerning the progress of the pig iron industry, and a prophecy as to its future, appeared in vol. XV of the tenth census, that of 1880, which is presented here to show how much more rapidly the industry has developed than was then anticipated would be the case eight years ago, when it was written.

"In 1866 the United States had reached the production of Great Britain in 1835, that is to say, she was then thirty-one years behind the latter country. In 1884 she was about twenty-one years behind England, and at the same rate of increase for both countries the United States will be about 15 years behind England in the year 1900, and will reach and pass her in 1950. The production of pig iron of each country for that year, as determined from the equation of their respective curves, being a little over thirty million tons."

The facts are that in 1890 the United States passed and has since that time led, Great Britain as a producer of pig iron.

In a paper read at a meeting of the American Institute of Mining Engineers, in October, 1890, by its then President, Hon. Abram S. Hewitt, he showed a comparative rate of interest in population and and pig iron production in the United States for six decades, and brought out the striking conclusion that the production of pig iron has always increased more rapidly than the population, and that the ratio is an increasing one.

Between 1830 and 1860 the production of iron increased twice as fast as the population. Between 1860 and 1890 it increased four times as rapidly, in reality over four times, thus proving that the national wealth continues to grow from decade to decade, at a rate of accelleration of which the world affords no previous example.

Inasmuch as during all this time the United States have imported iron in addition to their native production, it follows that the consumption per capita has also increased more rapidly than the population.

In 1855, according to careful calculations made by Mr. Birkinbine, the United States was consuming iron at the rate of 117 lbs. per head, whereas in 1890 the consumption had increased to rather more than 300 lbs. per head, the whole of which, for the first time in the history of the country, was being produced within American borders.

Mr. Birkinbine, in speaking of the present and future of the iron industry, deplores the fact that part of the development has been brought about by real estate speculations, which he rightly conjectures will exert a restricting influence in the near future. He is, however, of the opinion that:

"If political action does not disturb the industry, or if labor troubles do not seriously interfere with the development, there seems to be no reason for expecting that the pig iron industry will remain dormant, but we may rather look for a yearly steady growth, which at the expiration of 25 years will probably make the annual requirements of the United States in pig iron, or its equivalent, amount to between twenty and twenty-five million gross tons."

These figures Mr. Birkinbine states are the result of a careful study of statistics, taken in connection with an intimate knowledge of the present state of development, and a personal acquaintance with the possibilities of various portions of the country. He says:

"There will be times of depression like the present, preceded and followed by others of unusual activity, but we may confidently look forward to a material advance, perhaps greater than estimated, but certainly much more pronounced than was believed possible ten years ago.

Iron Ore.—The following figures taken from the "Report of Mineral Industries of the United States," at the 11th census, 1890, will give some idea of the magnitude of the iron industry of the United States.

In 1889 the production of iron ore in the United States including red hematite, magnetite, brown hematite and carbonate, amounted to 14,518,041 gross tons, of a total value of $33,351,978.

The total capital invested in the ore mines in the same year is given as $109,766,199. This is all expended within the country on the native ores.

In addition to this iron ore was imported in the same year from foreign countries to the extent of 853,573 tons, valued at $1,852,392.

With reference to foreign ore imported into the United States, Mr. Birkinbine in his "Production of Iron Ore," 1892, says:—

"While the United States has large deposits of iron ore of all kinds, widely distributed throughout the various states and territories, still the low rates of wages in foreign countries, and cheap water transportation rates, have admitted considerable quantities of iron ore into this country, in spite of a specific duty of 75c. per ton, which is collected on all iron imported. In the year ending December 31st, 1892, iron ore to the amount of 806,585 long tons, valued at $1,795,644 or $2.23 per ton, was thus imported. All of this iron however is consumed near the ports of entry, and much of the ore entering the port of Baltimore is unloaded direct from the vessels to the stock piles. This is also the case with one Pennsylvannia furnace.

"All the iron ore imported from Cuba is taken from the mines operated by American companies. Until 1892 but one company was mining and shipping ore from Cuba, but last year a second enterprise was represented by actual shipments, and 1893 is expected to add at least one more active corporation to the list of Cuban mines."

It is significant, in looking over the list of imports for 1889, to find that whereas Cuba supplied 243,255 tons, of a value of $535,524, the Provinces of Quebec, Ontario, Manitoba and the North-West Territories combined, supplied (be it remembered under equal conditions as to the tariff) only 4091 tons, of a total value of $10,697.

Again in 1892, statistics show that whereas Cuba supplied 307,115 tons, valued at $618,222, Quebec, Ontario, Manitoba and the North-West Territories supplied only 8,606 tons, and British Columbia 2,749, a total value for all Canada of 11,355 tons, valued at $27,340.

Spain was the largest supplier of ore in 1889, sending 298,568 tons, of a value of $621,481.

These statistics prove that up to the present time Canadians have found it impossible to compete successfully against the negro labor of Cuba, and the cheap labor of Spain, in supplying ore to the American market. The questions Canadians have to ask is whether under uniform free trade Canada can hope to improve her position as against her Cuban and Spanish competitors. This seems highly improbable. All the facts point to one conclusion, viz., that Canadians must turn their attention to smelting their own ore for the home market.

Equipment and Shipping Facilities.—The equpment of the American mines and furnaces surpasses in excellence that of any of the European nations, and the facilities they possess for cheap transportation of ore from mine to furnace is unrivalled. The shipping docks at Marquette, L'Anse and St. Ignace, Michigan, are worthy of special notice.

These docks have been constructed at a heavy cost by the railways which penetrate the interior, for the special purpose of facilitating the handling of Lake Superior ores at the minimum of cost, and they furnish a very striking example of the foresight and enterprise of American railroad men, who perhaps more than any other class, realize the national importance of the iron industry.

These terminal facilities consist of shipping docks, with elevated railroad tracks from 35 to 47.5 feet above water level. By means of drop bottoms the ore is dumped from the cars into pockets, thence to be discharged at will by means of iron chutes let down into the vessel's hold. By this system the ore is rarely, if ever, handled from the time it leaves the mine until it reaches lower lake ports.

The total investment for docks, specially equipped for handling and shipping iron ore, is placed, by so good an authority as Mr. Birkinbine, at approximately $4,000,000 in the year 1889.

Receiving Docks—Of equal importance is the system of receiving docks, specially erected for the purpose of handling ore to blast furnaces, or at points from which railroads radiate to blast furnaces.

These docks are of various types, generally furnished with swing boom derricks operated by steam power. By means of these derricks iron buckets are lowered into the holds of the vessels. After being filled with ore by the navvies, the buckets are raised again and swung to the point where the ore is to be deposited, or if for distant points, into hoppers, thence to be discharged into cars. The buckets dump automatically at the point desired, and return to the hold without detaching from the machinery.

It is estimated that the capital invested for receiving docks fully equals that mentioned for shipping docks, and that one such receiving dock alone costs, equipped, fully $800,000.

The investment, although large, is well spent, for by means of these facilities it has been found possible to handle quantities of ore which could not have been moved in any other way, while the cost of such handling has been reduced to a minimum.

Mr. Birkinbine gives the following data as to the cost of handling ore by the new system of receiving docks.

"The expense of shovelling ore into buckets in the holds of vessels varies from 10 to 15 cents per long ton, the rate being controlled by stevedores, while with the improved apparatus at some of the docks, this ore in buckets is lifted from the vessel, carried back 350 feet and dumped, at a total cost, including labor, wear and tear, interest, fuel accounts reported, of from 1 to 1.5 cts. per ton.

"With 21 men in the hold of a vessel, carrying 2,000 long tons of iron ore, the entire cargo has been stocked in 17 hours. Other instances are mentioned where with 28 men, 2,200 long tons were similarly handled in 15 hours, and 2,100 long tons were handled by 18 men in 17 hours.

"In using these improved apparatus in loading from stock piles to railroad cars, it is not uncommon to have a gang of men shovelling into buckets, and loading the ore on cars at the rate of 8 or 9 tons per man per hour."

In addition to these unrivalled facilities for economical handling of raw material, the American furnaceman works under most advantageous circumstances with regard to the large output of his furnace.

As an example, one of the furnaces in connection with the Edgar Thompson Steel Works, of Pennsylvania, recently produced the remarkable output for a single day of 623 tons of iron. In a week one furnace stack in connection with this company produced 3,203 gross tons, and in a month one stack produced 12,800 gross tons. That is in one month, one of these furnaces produced fully as much as twenty-five years ago would have been turned out in a year, from the best and largest of the American blast furnaces.

With such splendid facilities for economical working, with ample capital, and many other benefits accruing from a long continued policy of protection, the American iron industry stands to-day in a perfectly safe position, the trade (aside from the ordinary periods of depression common to all industries), bound to increase in volume, the whole future of the industry linked with the life of the nation.

CONTINENTAL STATES.

Following the example of Great Britain and the United States, France, Belgium, Germany, and other continental States, established, and still maintain, high protective duties with most beneficial results in many branches of the iron industry. Germany's case is especially worthy of mention.

On the 14th May, 1892, Bismarck, in a speech before the German Reichstag, said,—

"The success of the United States in material development is the most illustrious of modern times. The American nation has not only successfully born and suppressed the most gigantic and expensive war in all history, but immediately afterwards disbanded its army, found employment for all its soldiers and marines, paid off most of its debt, gave labor to all the unemployed of Europe, as fast as they could arrive within the territory, and still by a system of taxation so indirect as not to be perceived, much less felt. *Because it is my deliberate judgment that the prosperity of America is mostly due to its system of protective laws, I urge that Germany has now reached that point where it is necessary to imitate the tariff system of the United States.*"

Bismarck gave to Germany a protective policy with something of a permanent character, and the result has been the building up of a great national industry in that country.

In 1834 Germany and Luxemburg, included in the Zollverein, produced only 110,000 metric tons (2204 lbs.) of pig iron.

In 1881 Germany and the Grand Duchy of Luxemburg produced 2,914,009 metric tons (2204 lbs.) In 1890 the production had increased to 4,637,239 metric tons. This increase in pig iron has been accompanied by an enormous increase in the output of coal and lignite. As an illustration showing Germany's progress in the manufacture of basic steel, in 1890 England produced 503,400 tons of basic steel, Germany, Luxemburg and Austria, produced 1,695,472 tons.

IRON RESOURCES OF CANADA.

Canada's "natural fitness" for the successful establishment of the iron industry is beyond question.

The earnest work performed by the Geological Survey of Canada, and by private prospectors, has well established the fact that throughout a very large portion of her vast territory (three and a half millions of square miles in extent) Canada is rich in iron ores of almost every variety known to metallurgy.

Commencing at the Atlantic seaboard, Canada can claim in Cape Breton—extensive deposits of brown hematite, magnetite and spathic ores, lying side by side with coal fields of great magnitude.

Nova Scotia—The limonite, specular and spathic clay ironstone and hematite of Pictou County, specular ore in Guysboro County. At Londonderry an immense vein of ankerite, holding brown hematite.

Between Truro and Windsor numerous deposits of brown hematite, often highly manganiferous.

A range of ferriferous strata extending from Digby to Windsor embracing red hematite and magnetites of Nictaux and Clementsport. Throughout the whole of this district mineral fuel and fluxes occur in close proximity to the iron mines, affording exceptional facilities for economic furnace practice.

New Brunswick—Magnetic and bog ores, with coal fields at Grand Lake and elsewhere, and a plentiful supply of hard wood for charcoal purposes.

Quebec—The bog and lake ores of this Province are probably the most extensive of a like nature in the world. The ore bearing area extends from the borders of Ontario in the west, to Gaspé in the east, and on the other hand from the eastern townships to the Laurentian range of mountains, embracing the historical Three Rivers ore district.

Good deposits of magnetic ores are found at various points throughout the province, especially in the vicinity of Sherbrooke, Leeds, Sutton, St. Jerome and in Pontiac county.

An almost inexhaustible growth of hard wood, suitable for the manufacture of charcoal is everywhere found side by side with the iron deposits. Limestone for flux is most abundant throughout the province.

Ontario—Vast deposits of ore exist throughout Ontario from the Ottawa Valley to the head of Lake Superior. The ore is of many varities, magnetic, red hematite, limonite, specular, and occasionally bog ores, all more or less rich in metallic iron.

At the recent World's Fair in Chicago, Ontario exhibited no less than 120 samples of iron ore taken from her various mines, all these samples averaging 60 per cent. and over in metallic iron, and many of them exceptionally free from impurities. Most notable among the localities sending exhibits were the Ottawa Valley, including Lanark, and the Kingston and Pembroke district, Madoc and and other points in the county of Hastings; Haliburton, Coehill, and other locations in the county of Peterboro; East Algoma, Thunder Bay district, including the Atik-Okan range.

In the matter of fuel, Ontario, like her sister province, Quebec, possesses extensive forests of hard wood, admirably suited for the production of charcoal. She is also rich in fluxes.

Manitoba—Deposits of magnetic and bog ores on Lake Winnipeg, with an abundant growth of hard wood suitable for charcoal in the vicinity of the mines.

British Columbia—While the work of exploration has necessarily been limited, yet the magnetic ore deposits at Texada Island, and Cherry Creek Bluff are already fairly well proved by actual work. The ore from these mines has found a market at Tacoma, Wash., U.S.

British Columbia is very rich in both coal and wood, the outputs of her collieries at Nanaimo, Wellington and Comox showing a steady increase in tonnage.

While in the actual work of proving and developing her mines, Canada has up to the present accomplished comparatively little, yet the careful preliminary explorations already referred to have made it most evident that in raw materials nature has unquestionably endowed Canada with everything necessary to success.

CANADIAN MARKET.

Satisfied as to the possession of raw materials, the next most important question for Canadians, is the market for the finished product. All facts and figures go to prove that for many years to come Canada's natural market for iron products lies within her own borders, side by side with her mines and forests.

According to the best authorities, Canada uses to-day upwards of 250 lbs. of the products of iron per capita. This on a population of say five millions, means, roughly speaking, an annual consumption of 600,000 net tons.

In his report of the Bureau of Mines of Ontario for 1892, Mr. Arch. Blue estimates the consumption to equal (after making all due allowance for waste in converting pig iron into finished iron and steel) say, 604,252 tons for 1891-2. To better realize the accuracy of these figures, it must be remembered for instance that Canada possesses to-day not less than 15,000 miles of railway, standing high among the nations in this particular regard. When her 15,000 miles of railway line is laid with standard 72 lb. rails (the rail of the future) she will have at 113 tons per mile, in round figures, 1,500,000 tons of steel rails. The average life of a rail is 15 years, therefore renewals are being made continually, and as a matter of fact the Dominion is using in this department alone, 100,000 tons of the product of iron annually.

During the past year one of our great trans-continental lines alone imported 36,000 tons of steel rails. The Canadian railway companies if they follow the example of their American rivals, will heartily support the production of steel rails from Canadian ore by Canadian labor. The revenue to be obtained from the carriage of raw materials to the furnace, and of the finished product to the market, as well as through an increased passenger traffic, will more than compensate for the extra price they will be called upon to pay for rail equipment during the first few years of the industry.

All the rails used in Canada to-day are of foreign make.

As a further illustration, the rolling mills at Montreal, Hamilton, Swansea, New Glasgow, N.S., and elsewhere, are producing annually, at a fair estimate, 80,000 tons of the products of iron. Unfortunately the raw material for this output is very largely foreign, although there is no good reason why within the next few years every ton of this should not be supplied by Canadian labor from Candian ore.

Our iron founders use annually about 80,000 tons of pig ron in casting such as stoves, agricultural implements, and machinery of all classes, one-half only of the material used in this class of work being the production of Canadian furnaces.

Aside from these leading lines the country consumes each year a large quantity of such products as band and hoop iron, special quality bar iron, steel boiler plates, steel sheets, sheet iron, chain cables, slabs, blooms, bridge and structural iron, railway fish plates, rolled beams, nail and spike rods, wire, locomotive tires, iron and steel for ships, steel ingots, bars, and other forms of iron too numerous to mention, but almost wholly the product of foreign labor.

In railways and shipping Canada pretty well holds her own, proportionately to population, with either Great Britain or the United States.

Possessed of the necessary raw materials, and reasonably protecting her own home market, there is no reason why she should not, in proportion to her population, hold an equally prominent position in her iron industries.

The history of the Canadian iron industry dates back to the establishment of the St. Maurice forges by the French Government about the year 1737. This was followed at various periods by the erection of iron works at Batiscan, L'Islet, Hull, Baie St. Paul and Mosiac, in the Province of Quebec.

Furnace Falls, Normandale, Marmora, Madoc and Houghton, in the Province of Ontario.

Woodstock, in New Brunswick.

Moose River, Nictaux and Bloomfield, in Nova Scotia.

In course of time each and every one of these enterprises had to succumb to the competition of foreign iron, then admitted free of duty into Canada.

In addition to the difficulty of competing with the more advanced industries of other countries, Canadian pioneer furnacemen labored under many grave disadvantages. The records in every instance speak of small outputs, lack of capital, lack of shipping facilities, mismanagement—good and sufficient reasons in any country, or in any branch of industry, for ultimate failure.

In not a single case has it been shown that lack of raw materials necessitated the closing down of a Canadian furnace. It is true that an almost absolute want of proper shipping facilities in these earlier days, made it troublesome and costly to procure raw materials, and deliver them at the furnace, but this difficulty has long since been removed by the easy shipping facilities afforded through the network of railways now in operation all over the country, not to speak of the perfect waterways and splendid system of canals now possessed by the Dominion.

Passing over the pioneer stage, we come to perhaps the most important epoch in the history of the iron industry in Canada, viz., the introduction of the protective tariff on iron, which came into force in 1887. The tariff as then framed, and still in force, was based upon the American tariff of import duties on iron and steel, and their products, in the proportion of about two-thirds of the said American tariff, and unquestionably the Dominion Government designed the tariff with a view to protecting native Canadian labor against the cheaper labor of Europe, and the better equipment of the United States. It was evidently the intention of the Government in doing this to afford, at least approximately, an equal ratio of protection to labor, in whatever branch of the industry it was employed, as this is the system upon which the American tariff is undoubtedly based, and the only system possible of complete success.

Unfortunately the Dominion Government made one mistake, viz., the admission of wrought scrap iron, as the raw material for the manufacture of bar iron, at a less rate of duty than puddled bars, blooms and billets, with which it came into competition. This exception is, as Sir Charles Tupper once said, the "one blot" on the tariff, for it has ever since deprived Canadian furnacemen of a home market for their forge iron, a class of iron which in the order of things they must necessarily produce from time to time, and which should be used by Canadian rolling mill men as their raw material for bar iron, either in the shape of puddled bars, or soft steel billets as the trade may demand.

The admission of scrap iron at a low rate of duty has resulted in two evils. First—It has retarded the progress of the manufacture of pig iron from Canadian ores, inasmuch as the iron masters cannot afford to produce puddled bars or steel billets at competitive prices with cheap wrought scrap. Secondly—It has caused the Canadian rolling mill proprietors to make investments in special plant for the manipulation of scrap, and brought a condition of affairs in the rolling mill business that would be greatly disturbed by any sudden change in the tariff with regard to the admission of wrought scrap.

It is the plain duty of the Government to rectify the mistake it has made, but to do so with due regard to the vested interests of all sections of the industry.

This may be done in several ways, for instance, by naming a definite date, say within from three to five years, when wrought scrap, the present raw material for Canadian bar iron, shall be placed at the same rate of duty as puddled bars, or steel billets, with which it comes into competition, and that in the meantime a sufficient bounty be granted, either to the rolling mill companies on such iron and steel as they may produce from the products of Canadian blast furnaces, or to the blast furnace companies direct, as an inducement to them to produce steel billets and puddled bars, so that they may shortly be in a position to supply the mills (at a reasonable living profit to themselves), with all the raw material necessary for the manufacture of bars and other finished iron.

It is not improbable but that a comprehensive arrangement on some such lines would result in the rolling mill companies considering the question of going into blast furnace work on their own account, with most beneficial results to the whole Dominion, or they may adopt the course of erecting plant for the manufacture of steel billets and puddled bars from the Canadian pig iron.

In the face of many difficulties the pig iron industry has continued to make creditable progress since 1887, and especially has this been the case within the past two years.

At the close of the calendar year 1891, the total production of pig iron in Canada was only 23,891 tons. Within eighteen months, that is to say, at the close of the fiscal year 1892, the output had increased to about 51,000 tons for twelve months, a gain of upwards of 95 per cent. 60,000 tons will be a fair estimate of the output to the close of the present fiscal year.

The following will show the furnaces now in blast, with capacity and output :—

Londonderry Iron Co.,
Londonderry, N.S.

Description of Plant, with Capacity.

36,000 acres of freehold land.
Ore mines yield from 50,000 to 70,000 gross tons.
Limestone mines yield from 12,000 to 15,000 gross tons.
Railways, about 12 miles, company's own property.
Two blast furnaces, capacity about 40,000 gross tons.
One rolling mill (silent) " " " 8,000 "
One pipe foundry " " " 5,000 "
Number of men employed, about 350.
Maximum number which has been employed when running all departments full, 807.
Make of pig iron (1892) - 28,052 net tons.
Ore charged (partly bought) 64,430 "
Coke " - - - 41,006 "
Coal " (all bought) - 1,740 "
Flux - - - - 14,907 "

The Londonderry Co. purchase from outside sources a very large proportion of their ore and coke. It is therefore altogether fair to credit them with the hands employed in the production of this material, in all some 450 men. This gives a total of 800 employees connected directly and indirectly with the operations of the Londonderry Co.

New Glasgow Iron, Coal and Railway Co.,
Ferrona, Pictou Co., N.S.

Ore mines, limonite and hematite, yielding 60,000 to 75,000 tons per annum.
Coal mines; limestone quarries.
Railways, the property of the company, about 13 miles in length, connecting the furnace with the mines.
One blast furnace, 65 ft. high, bosh 15 ft. 6 in., hearth 9 ft. 6 in., capacity, 100 tons per day.
Battery of coppe kilns.
Number of men employed, 425.
Iron produced in 1893, for nine months campaign, 22,500 net tons.
Ore, about 50,000 net tons.
Coke, 30,000 "
Flux, 13,000 "

The company purchase all the coal required for the operations of the furnace. Last year they bought, washed and consumed 90,000 tons of coal. It is only fair to credit the industry with the men steadily employed in the fuel department, viz., 150 men and 50 boys, giving a total average of 625 employees in connection with the Ferrona works.

Allied with this company, and as an important consumer of its forge iron, is the Nova Scotia Steel and Forge Co., Ltd., of New Glasgow, N.S. The following description will show the great importance of this steel industry.

The plant consists of:—
Two Siemens melting furnaces, 20 tons capacity each.
Three gas heating furnaces.
Five reverberatory heating furnaces.
26 in. reversing cogging mill, with train of live rolls.
Heavy vertical hot billet shears, with live rolls.
One 20 in. plate mill.
One 16 in. bar mill.
One 12 in. bar mill.
One 9 in. guide mill.
Ten pairs shears, 40 tons and smaller.
One 5 ton steam hammer, with 15 ton hydraulic crane.
Four smaller steam hammers.
Machine shop 175 ft. x 75 ft., with 30 ton travelling crane commanding whole shop, equipped with 24 in. slotter, 6 drills (one a 9 ft. radial, 5 in. spindle), 9 lathes, one of which will take in 50 in. over carriage, and 8 in. x 10 in. in the gap, will take 37 ft. between centres, small shapers, etc. Power is supplied by some 50 steam and 10 hydraulic cylinders. Entire works are lighted by arc and incandescent light plant.

Output, 100 tons of steel ingots per day, all of which is worked up into bars, sheets, axles and other forgings.

Over 97,000 axles of this company's make were supplied to Canadian railways.

This company employed in 1893 an average of 425 men at the works, and expended in wages to this staff $185,471.00. Aside from this they should be credited with the labor necessary to mine and raise the average quantity of ore required per day, in all one hundred men, giving a total of 550 men connected with the Nova Scotia Steel and Forge Co., Ltd.

The company consumed 36,000 tons of coal in 1893.

It may be mentioned also that they paid in 1893 for freights, inwards and outwards, $86,667.61.

The Pictou Charcoal Iron Co., Ltd.
Bridgeville, N.S.

Ore mines, brown hematite and limonite, in the immediate vicinity of the furnace.

Wood supply, the company controls 8,500 acres of hard wood lands, yielding principally yellow birch, beech and maple. This land is situated 15 miles from the furnace.

One blast furnace, 55 ft. high, 11 ft. bosh, built of red brick; capacity, 5,000 tons charcoal per annum.

Charcoal kilns, 19 beehive kilns, capacity 50 cords each.

This company has barely commenced operations. So far only 700 tons of iron have been produced. Working full blast, however, it will give employment to 300 men in the woods, mines and at the furnace.

John McDougall & Co.
Drummondville, Que.

Ores, bog ores secured within a radius of 12 miles of Drummondville.

Charcoal fuel, soft wood, principally balsam and spruce secured in practically the same district as the ores.

Two furnace stacks, both built of stone, 35 ft. high; capacity, about 6 tons per day each.

Two hundred men employed.

At present the whole of the output is used in the manufacture of car wheels at the company's works in Montreal. The campaign is therefore largely regulated by the requirements of the car wheel department.

The Canada Iron Furnace Co., Ltd.
Radnor Forges, Champlain Co., P.Q.

Ores, bog and lake. The company control 100,000 acres of ore-bearing lands in the districts of St. Maurice, Three Rivers, Vaudreuil, Joliette, St. Ambrose de Kildare, Point du Lac, Gentilly and Beaconcoeur, including the important deposits of lake ores at Lac-a-la-Tortue and Lac-au-Sable, which the company hold in fee simple. Also magnetic iron mines at Sherbrooke, St. Jerome and other points in the province of Quebec.

Wood supply, freehold and royalty rights on hard wood lands extending throughout the country north of Radnor Forges. The supply of wood is practically inexhaustible.

The company's location at Grandes Piles, securing to them the "key" of the St. Maurice River, and the control of most valuable hard wood lands on either bank of the river for seventy miles of the navigable waters of the St. Maurice. The wood is principally hard maple, birch and beech.

Charcoal kilns, a battery of 11 kilns on the furnace property at Radnor Forges, capacity 55 cords each; a battery of 14 kilns at Grandes Piles, capacity 55 cords each. Charcoal also made in pits in the Swedish manner.

Limestone quarry, the company own what is perhaps the most important limestone quarry in the Three Rivers district. This lies within 50 yards of the furnace.

Railways, a railway line from Piles Branch, Canadian Pacific Railway, to the furnace. This together with switches is three miles in extent, all the property of the company.

Car wheel foundry located at Three Rivers.

Furnace, iron shell, height 40 ft., bosh 9 ft. diameter. Crucible and bosh from mantle down is encased and protected with a Russell Wheel and Foundry Co. water jacket. The furnace is complete with all modern accessories. Hot blast stove, Drummond pattern. Steam and water power. New Weimer blowing engine, also complete auxiliary plant blowing engines, steam and force pumps ready for use at any moment should the permanent plant become disabled. Capacity 40 tons per day of high class charcoal iron, specially adapted for the manufacture of chilled car wheels.

This iron stands an average breaking strain of 63,000 lbs. per square inch, the test being on standard bars 1 x 12 inch.

During 1893 the company produced 7,423 net tons of charcoal pig iron. They made all their own raw material, not alone for the production of the quantity of iron named, but also for sufficient stock to provide for a largely increased output during the present year, 1894.

The average number of men employed is 650, with about 400 horses.

During the winter months when the company require to cut all the hard wood necessary for the year's production of charcoal and when they take delivery of a great deal of the ore made during the summer months, they often find it necessary to employ a staff of upwards of 860 men, with about 550 horses. Of this large staff of men at least three-quarters are drawn from the ranks of the farmers or habitants, and the operations are carried on by them over a very large territory.

Importance of the Canadian Iron Industry.

Politicians will do well to notice that each and every one of the Canadian blast furnaces are located in rural districts, and that in a very peculiar degree the pig iron industry is one closely identified with the interests of the farmer.

The coke furnaces of Nova Scotia draw a large proportion of their employees at mines and furnaces from the farming class. In many instances farmers take work in the mines, while other members of their families look after their agricultural interests.

The charcoal iron furnace especially may well be classed as a farmers' industry. For example, in the case of the Canada Iron Furnace Co. already cited, out of a staff of 850 men employed at the present time, 700 at least of the employees are farmers or habitants, who work for the company during the winter months and in their slack seasons between seed time and harvest.

These men find that the arduous work of clearing their land is no longer profitable, as it has been in the past, but that on the contrary they are now able to derive a very good living from the earliest days of settlement, by supplying wood to the charcoal kilns.

Another ready source of employment is the raising of ore on portions of their own and neighboring land, which would otherwise be wholly unproductive.

The successful re-establishment of this charcoal iron industry at Radnor Forges has greatly improved the condition of the farmers of the historical Three Rivers district. They now find ready and profitable employment on their own land at all seasons, a steady market for their farm products, and ample work for their horses.

During the present season the Canada Iron Furnace Co. are using in their camps and ore fields upwards of 500 horses; 80 per cent. of which are the property of farmers.

This close identity of interest between the farmer and the manufacturer is also characteristic of the work done at Drummondville, in the Province of Quebec, and will no doubt prove equally true with regard to the operations of the Pictou Charcoal Iron Co., at Bridgeville, N.S.

It will be largely in the interests of the farmers of Ontario and Quebec if the charcoal iron industry is allowed to grow and prosper. What has been possible in the case of Sweden is equally possible with the Provinces of Ontario and Quebec, where the raw materials and market lie side by side.

In 1890 Sweden had in blast 154 charcoal iron furnaces, producing 456,102 metric tons, an industry of which that nation may well be proud.

The utilization of the hard and soft woods of our forests, at present waste material, would be of incalculable benefit to the provinces of Ontario and Quebec, and above all to the agriculturists of these provinces.

Next to the farming class, the railways would perhaps be the greatest gainers by the establishment of an iron industry.

In that case of the Government railway, the Intercolonial, it is safe to say that the combined operations of the Londonderry Iron Co., the New Glasgow Iron, Coal and Railway Co., and the Nova Scotia Steel and Forge Co. furnish one-fifth of all the freight business of the railway in question.

The Piles Branch of the Canadian Pacific Railway, on which the works of the Canada Iron Furnace Co. are located, is perhaps the best paying piece of line possessed by that great trans-continental road, and this is very largely due to the fact that every pound of raw material inwards to the furnace and finished product outwards to the market contribute to the revenue of the railway company.

It is plain that any policy that would serve to cripple these iron industries *will be severely felt by the railways. Perhaps the greatest difficulty that has stood* in the way of the advancement of the Canadian iron industry up to the present time has been the uncertainty of the tariff, and political cries of "Commercial Union," "Unrestricted Reciprocity," "Free Trade" and "Revenue Tariff," have served to frighten capitalists, so that Canadian iron masters have found it very difficult to obtain investors for the carrying forward of the work on a proper basis. When the difficulties are all considered, it is remarkable that the industry has reached even its present stage.

The United States at the present time presents an example of what uncertainty regarding tariff changes will do. During the past six months business has been completely demoralized in the iron trade of the Republic by the fear of a possible change in the duties. This in face of the fact that both parties in Congress are known to be more or less protectionist in theory and practice, the difference being only one of degree, whereas in Canada politicians are most extreme in their views, and the battle against protection to native industries has been waged in and out of Parliament during all the term that the so-called National Policy has been in existence.

With such a nucleus as the existing establishments afford, with unlimited supplies of raw material, and possessing the best of all markets—a home market—the Canadian iron industry cannot fail to expand rapidly and safely, probably as in the case of the United States much more rapidly than the population, if only the Government of Canada will establish confidence in the minds of capitalists by, in some manner, giving a degree of permanency to the present protective tariff. Minor details will from time to time require adjustment, but the broad principle of protection to an industry for which nature has so eminently fitted the Dominion, must be endorsed by both Government and Opposition, giving a fair period of time in which to secure a full development of the industry, so that it may meet on something like equal terms, the opposition of its powerful competitors in the United States and Great Britain. Without this the industry will be restricted, and in times of depression such as the present, the iron masters of the United States will simply unload their bankrupt stocks into Canada, with the end that a healthy Canadian industry will be an utter impossibility.

It is a notable fact that during the past four years the increased outputs of the Canadian furnaces has led to a decreased cost of production per ton of iron, and Canadian makers have now forced foreign agents to lower their prices fully $3 per ton from prices asked four years ago. A well maintained tariff for some years to come will have exactly the same tendency as it had in Great Britain and the United States, viz., to strengthen and expand the native industry to the point where Canadians can control the entire trade of the country, and yet sell to the consumer at as low a price as any foreign competitor can do in his own country.

Location.

The question of the proper location of coke and charcoal furnaces will be settled by the natural fitness of each province. Nova Scotia, possessing as she does a great wealth of mineral fuel, must continue for some years to come to produce the coke iron required by the country. It may be urged that she is far removed from her best market, viz., Ontario. However, Nova Scotia is in quite as good a position in this respect, and ought to be in regard to freight rates, as her present greatest competitors, viz., the furnaces of the Southern United States. Within the past two years Nova Scotia has made great progress in the erection of modern plants and improved appliances. She must continue on this course, for the time is past when iron can be successfully produced without improved appliances both in construction and modern methods of operation. The blast furnace must meet the consumers' wants in quality of iron, and technical knowledge and *administrative* ability must be joined together in Canada just as in the United States, to secure the increased output and the high quality of iron which the times demand. Quebec and Ontario afford a splendid field for the development of the charcoal iron industry, and this department will become more and more important as the forests of the neighboring republic and Sweden are depleted.

It is hardly feasible under *existing circumstances* to successfully establish coke furnaces in either Ontario or Quebec, inasmuch as these provinces would have to depend upon importing their supply of mineral fuel from the United States. Such an industry would be of little value to the provinces or the Dominion inasmuch as by far the largest proportion of labor required in the manufacture of iron is that connected with the mines, both coal and iron. Certainly the Government would not be warranted in granting a bounty for the establishment of an industry contributing, as largely as this would, to the labor of our most important competitor, the United States.

There is a reasonable hope that in due time Nova Scotian coal will be profitably coked at Montreal and other centres of population by the utilization of by products.

When that time comes Ontario and Quebec will be in a position to operate blast furnaces economically with mineral fuel, the product of Nova Scotian mines, thereby adding another link to strengthen the confederation of the Canadian provinces.

For the immediate future the charcoal iron industry offers the best and surest field of operation and investment to the provinces of Ontario and Quebec.

A full and unbiassed investigation into all the facts concerning the successful establishment of the iron industry in other countries, and of the circumstonces attending the work already done in Canada, leads to the following conclusions:

First—That the Canadian iron industry has greater and more just claims to the good will and support of the government and people of Canada than perhaps any other of the great industries of the country. In tobacco, sugar and cotton splendid progress has been made, yet these industries, whilst of unquestionable benefit to the country, all contribute more or less to the labor of foreign countries, by using raw materials of foreign growth, for which nature has not fitted Canada. The iron industry is altogether different, being purely Canadian from *raw material to finished product.* Nature has richly endowed Canada with everything that goes to make success in this special line of enterprise. It rests with the government and people of the Dominion to foster the industry to a perfect development.

Second—The Dominion Parliament must immediately adopt a course that will give confidence to investors, by demonstrating that the protective tariff and bounty will be well maintained for some time to come. The Government must rectify judiciously any errors that may have arisen, and must seek at least approximately *to grant a uniform protection to labor, in whatever branch of the industry it may be employed,* be it at the mines, furnace, rolling mill, iron foundry or machine shop.

Third—The Provincial Governments must take steps immediately to encourage by every reasonable concession the development of the iron industries now within their respective borders.

In Quebec and Ontario every facility should be granted by the Provincial Governments in the way of privileges for the clearing of hard and soft woods from Crown lands. This course will not only strengthen and build up the charcoal iron industry, but will bring about a rapid settlement of Government lands.

Hitherto settlers have avoided the forest lands of the east, in favor of the more easily cultivated prairies of the west. Establish the charcoal iron industry in Quebec and Ontario, and the settler will find a sure and profitable return for labor expended in clearing the wood, and the inducement will make the bushlands of these provinces more attractive than the prairies of the west.

The section of the different provincial mining laws, providing for a proper expenditure in the development of mining locations within a given time, should be strictly enforced, and if possible the obligations made even more stringent than at present, so as to ensure a fair amount of work being done promptly, and prevent as much as possible the "locking up" of valuable mines by speculators.

Where the owners of locations are too poor to carry on the work of development in a proper manner then the Provincial Government should do so by some equitable arrangement with the owner. For this purpose the Provincial Legislature should vote in each year's supplies a reasonable sum of money. This would serve to bring about a business-like development of some very valuable mines that now lie dormant, and must in time bring a very profitable return to the Government by the settlement of Crown lands.

Further it would tend to prove to capitalists that the ore supplies are all that they are claimed to be, and ample for all requirements.

The Provincial Governments require to deal with the whole question in a business-like manner strictly enforcing laws that will tend to an early development, but at the same time they must be heartily in accord with the Dominion Government in granting every legitimate encouragement and facility that will tend to build up so valuable an industry.

Fourth—Canadian bankers, capitalists, and men of affairs generally will do well to give the native industry more attention in the future than they have in the past. An industry that is peculiarly Canadian in every branch, drawing all its wealth from Canadian soil, is surely worthy of their legitimate support. The fact that the earlier iron industries of this country failed to succeed under the most adverse circumstances, is no reason why, under existing conditions, undeniably more favorable, the industry cannot be made a thorough success, not alone affording a great field for a safe investment of capital, but indirectly benefiting other existing Canadian industries and interests, aiding towards increased population and national wealth.

Let the Canadian Government and people go steadily onward and by every energy and sympathy build up great national industries and interests, neither doubting themselves nor their resources, but rather cultivating in every department of trade and commerce and in the hearts of the people that national pride in national products so characteristic of Englishmen and Americans. Following such a course Canada must soon develop not only in her iron industry but in every department of national life.

Ore Sampling.

By J. T. Donald, M.A., Montreal.

Worcester defines a sample as "that which is taken out of a large quantity as a fair representation of the whole." Webster says a sample "is a part of anything presented for inspection as evidence of the quality of the whole."

Ore sampling may therefore be defined as any process which will enable us to obtain from a large quantity a fair representation of the whole. To fairly sample a pile of ore is really no simple matter, although there are many engaged in mining who think that all that is necessary is to pick up one or more pieces from the pile at random, and call this a sample.

For instance, sometime ago a gentleman brought me a lump of phosphate weighing about a half a pound as a sample of a pile of about 200 tons. He said he considered it a fair sample, although the pile contained some better and some worse, and requested that it be analyzed. A few months later the ore was sold, and the purchaser had the pile properly sampled; the results of analyses in the two cases, it is needless to say, showed a marked difference.

On another occasion, a company engaged in mining a certain ore determined to send samples to Canadian and English chemists. The party who was detailed to draw the samples went to the pile, selected a few lumps of ore and laid them aside as one sample; he then collected another few lumps of similar size and considered the latter as a duplicate of the first. In due time the certificates of analyses of these samples, by English and Canadian chemists, were laid side by side, and as might be expected were far from agreeing closely. The company who owned the ore blamed the chemists, and the chemists, of course, declared that the fault lay with the samples, and as a chemist I am bound to say I quite agree with the view that the sampler was the party at fault.

As a matter of fact, I may be permitted to say that one of the greatest difficulties with which the analyst has to contend is defective methods of sampling. It is no uncommon thing for a chemist to hear a miner say you analysed for me a sample of phosphate, and when the cargo was sampled and analysed in Hamburg it went much lower than you made it. It must be borne in mind that it is most unfair to hold an analyst responsible for anything except the accuracy of work on the actual sample on which he has worked. If a miner instructs a chemist to sample and analyse a pile, then it is another matter.

The time was when chemists working on duplicate samples did not always obtain closely concordant results, for the reason that different methods were employed by different chemists. This condition of affairs is a thing of the past, and now throughout Europe and this continent uniform methods of analyses are employed in the valuation of the more important ores of commerce, with the exception of copper, which in America is determined by the electrolytic method, whilst in Britain the old Cornish assay flourishes.

The ideal method of ore sampling is to crush the whole parcel, and then let it fall in a steady stream through a machine which, working automatically, diverts at fixed intervals, and for a fixed length of time, a portion of the stream of falling ore. For instance, a stream of ore may be allowed to fall vertically for two minutes, then that which falls during the third minute is thrown automatically away from that which fell during the first two minutes, then for another two minutes the ore falls vertically, then again for one minute the stream is deflected, and so on. In this way the whole parcel of ore is divided into two lots, one containing two-thirds of the original parcel, the other one-third. The latter part is then taken and put through the same machine, exactly as was the original lot, and similarly divided. The lot deflected from the main body in this second process now constitutes one-ninth of the original parcel. It may be put through the process a third time if desired; and in the latter case, the deflected part will represent one twenty-seventh of the original parcel. This portion is next spread out and quartered, and an equal quantity taken from each quarter. This portion is again quartered and a portion taken from each, and so on until a sufficiently small quantity has been obtained, and this last is considered a sample. I think no one will deny that a sample thus obtained will undoubtedly fairly represent the whole.

The method outlined is that which is in use in the large copper ore and matte sampling works in New York; but, of course, it cannot be carried out in the case of quantities of ore which have to be sampled at the mine or any point except the sampling works. Nevertheless, all sampling should aim to approach as closely as circumstances will permit to this ideal method.

To see how closely this ideal method may be approached, let us suppose the case of a quantity of phosphate in bins, and it is required to draw a sample for analysis, the sampler acting for both buyer and seller.

If not fairly level, it is advantageous to first level the pile, and then to place stakes at points, say ten feet apart. Next, workmen, at these marked points, dig down through the ore until the bottom of the pile is reached, and in digging the contents of say each fifth shovel is thrown into a box and carried off to a level floor; when the bottom of the pile has been reached at every staked point, the portion that has been carried off is broken into fragments not larger than an egg, thoroughly mixed, then spread out and quartered, and the selected portion is again crushed, so that now it will contain no lumps larger than an almond. This portion is then mixed and quartered, and so on until a sufficiently small sample is obtained, this may be a quantity that will fill an ordinary pickle bottle.

If ground ore in bags is to be sampled, it will suffice to take a portion from the middle and bottom of every fifth bag, the whole lot thus drawn should be mixed and quartered as already explained.

Closely related to ore sampling is ore grading, which prevails to a certain extent in all mining regions. There is, however, one distinctively Canadian ore which nominally is graded, but in which the grading is of but little importance, for the reason that there is no uniformity in grading, and since it is an ore whose value cannot be determined by analysis, grading is all the more necessary. I refer to asbestos. It is well known that No. 1 grade of some producers is no better than the No. 2 of others, and a purchaser buying No. 1 ore is by no means certain of the character of the ore he will receive. Such a state of affairs is a blot on the asbestos industry, and should be removed. In the case of wheat and flour, for instance, standards are chosen by parties appointed for the purpose, and these are accepted by the trade as standards. Why cannot the same thing be done for asbestos? It should not be difficult for producers to agree upon standards, and to grade their ore accordingly.

Certainly closer attention to sampling and grading ore on the part of miners would tend to an increase of good will between buyers and sellers, and would in the end be directly profitable to the miner.

The Annual Dinner.

Wi' merry sangs, an' frien'ly cracks,
I wat they did na weary;
An' unco' tales and funny jokes—
Their sports were cheap and cheery,
Till butter'd sow'ns wi' fragrant lunt
Set a' their gabs a-steerin'
Syne, wi' a social glass o' strunt
They parted aff careerin',
Fu' blythe that night.

About forty members and their friends sat down to dinner in the Windsor Hotel on Thursday evening. In the absence of the president, who had been called home during the afternoon, Mr. George E. Drummond (Canada Iron Furnace Co.), vice-president, occupied the chair, having on his right His Worship the Hon. A. Desjardins, Mayor of Montreal, and on his left the Hon. E. J. Flynn, Commissioner of Crown Lands for the Province. Among other notables at the head of the table we noticed Mr. John F. Stairs, M.P., Halifax; Mr. Graham Fraser, managing director of the New Glasgow Iron, Coal and Railway Co., Ferrona, N.S., and Mr. James King, M.P.P., Quebec. The tables were tastefully arranged in the form of a horseshoe, and the menu and service was everything that could be desired. Unfortunately, through a misunderstanding, the company was deprived of the services of the orchestra, which had been engaged to play during dinner, but whatever deficiencies may have been at first experienced in this regard were amply compensated for by the musical efforts of individual members, notably by Mr. Fritz Cirkel, M.E., whose brilliant execution at the piano, accompanied by a fine variety of vocal selections, contributed much to the pleasures and success of the evening.

The Chairman intimated apologies from the following: Hon. T. Mayne Daly, Minister of the Interior; Hon. A. S. Hardy, Commissioner of Crown Lands, Toronto; Mr. Arch. Blue, Director of Mines, Toronto; Hon. George Irvine, Q.C., Quebec; Mr. W. W. Ogilvie, President of the Board of Trade, Montreal; Sir J. W. Dawson, Montreal; Dr. A. R. C. Selwyn, C.M.G., Ottawa; Mr. H. S. Poole, President Mining Society of Nova Scotia, Halifax: and others. The toast of the Queen was then given and loyally honored.

Capt. R. C. Adams—I have very much pleasure in moving that we drink a bumper to "Our Guests." I feel that we are very fortunate in having as our guests to-night gentlemen in power—representing governments—because this Association was formed primarily on the principle of the Irishman who, when he landed on an island, at once inquired: "Is there a government here?" and on being informed that there was, exclaimed "Then I am agin it." (Laughter.) The General Mining Association was formed primarily to be "agin" the Government. We found that laws were being passed which oppressed our industries, although instead of being in the position of many people who were constantly running to Ottawa and Quebec soliciting and securing special favors for their industries, we were demanding nothing at all further than to be let alone. Not only was our mining industry receiving no protection, but taxes were being suggested which threatened its existence; so we organized to secure the repeal of these bad mining laws, and, gentlemen, we are glad to say we have succeeded. (Applause.) We have succeeded in having these obnoxious laws repealed. The good efforts of the Hon. George Irvine, our late esteemed president, who formulated the objections to the Mercier law and pressed them upon the Government, were entirely successful. (Applause.)

It is, I take it, a sure sign of our success that we have so many representatives of the Government with us to-night. We are delighted to be honored with their company. We have the Hon. Mr. Flynn, the Commissioner of Crown Lands, to whom we must all go in the first instance to get our land. We consider him really as the Father of the whole mining industry in Quebec, and we feel it especially appropriate that he of all others should be with us. (Applause.) We hope that he will gain enthusiasm in regard to our Association and our industry, and if there is any bare possibility of the system under which he is working being improved, we trust it will be exercised in our favor. We certainly have no complaints to make at present. (Applause.) I think we have shown our appreciation of the political party which he belongs to, which I believe is popularly called in Quebec the *Bleu* party, by electing as our President Mr. John Blue. (Laughter.) It was felt that we must have some one who was really "True Blue." (Applause.)

Then, too, we have with us our old friend the Hon. A. Desjardins, the honored representative of our city, who so gracefully and admirably fills the position of its mayor. (Applause.) Without making any comparison with the past, we may say how thoroughly we appreciate having a "gentleman" in the civic chair.

These were perhaps "hard times" for some of the mineral industries—phosphate, asbestos, silver—but I am often comforted in such times by remembering the words of a good old business man, who said that "blue times" was the time for action—that in hard times men make their greatest success, because then they have to find out what new methods they can adopt and what new devices they shall undertake. In his able paper last night, Mr. Smith gave us one of those instances by his use of the diamond drill to get at the minerals, showing how hard times induce men to undertake new economies in place of the old worn out methods; so, gentlemen, I feel that while we congratulate our guests we might also take courage ourselves and resolve that we are not going to let our mineral interests go down, but that we will adopt wiser methods and better economies, and try to let this old Province of Quebec still raise her head and take rank as foremost in the Dominion in the production of minerals, an industry which next to agriculture is at the bottom and foundation of the nation's growth. I hope we shall take encouragement from this conference with each other, and get to work anew to do what we can to make the coming year a year of progress and prosperity. Before I sit down I will tell you a little bit of witticism that I heard out west, which came into my mind in connection with the mention of the color blue. I was in British Columbia this summer, and there was a man named Brown in a mining camp who had been engaged in the manufacture of charcoal, and therefore had earned the name of Charcoal Brown. One day a stranger came to the camp and said, "Boys, do you know of anybody here by the name of Black." One of the men said, "No, there is nobody here named Black, but there is a man named Charcoal Brown; that is the nearest we can come to it." Some of us here are not quite as *bleu* in politics as we might be, and are even tinged with *rouge*, but the nearest we can come to it is to be true blue in our loyalty to the mining industry. I have much pleasure in giving you the toast of "Our Guests."

MAYOR THE HON. A. DESJARDINS—I have to thank Capt. Adams for his kind reference to myself and you gentlemen for the heartiness with which you have received this toast. A mayor is a short lived individual. I feel this particularly to-night, for although a year has passed, it seems only as yesterday when I made my first public appearance as Mayor in your company, when we assembled in this place to welcome the American Institute of Mining Engineers and the other mining men who came to Montreal under the auspices of your Association, with my friend Mr. Bell, always active, always energetic, always ready. (Applause.) Well, gentlemen, I heartily welcome you again to Montreal. Your conventions, your meetings, your lectures and those periodicals which are published under your control are excellent advertisements abroad of the wealth and possibilities we have in our country. You have done much to make that wealth known elsewhere and I sincerely wish you continued success and prosperity in your undertakings. (Applause.)

HON. E. J. FLYNN—I feel exceedingly pleased to have the honor this evening to meet at this table so many distinguished representatives of the mining industry of the Province of Quebec. I thank you Mr. Chairman and you Capt. Adams for the kind reference to myself and my work. I regret very much that last year, when your Secretary kindly tendered me an invitation to be present as your guest and also to take part in the mining convention, that through the performance of my public duties, I was prevented from being with you. I saw in the papers the result of your deliberations and what took place and I am now consoled by the thought that I can peruse attentively the very interesting papers which were read on that occasion in the very interesting *Journal* of your proceedings recently published, and which is now about to be distributed throughout the Province of Quebec and the Dominion (Hear, hear.) When I left Quebec yesterday to attend your dinner I did not expect to have had the opportunity of uniting business with pleasure, but I have been more than pleased to have been present at your sessions yesterday and this afternoon. I must say that the papers which have been read were of the most valuable and interesting character and I avail myself of this opportunity to tender here publicly my most sincere thanks and my congratulations. I will be allowed to do so, I presume, in my capacity of Commissioner of Crown Lands. The good work you have been doing, as His Worship the Mayor has said, is an advertisement of the mining resources of the province. What we require is capital to develop these resources. The Government of the day has passed what I think you will admit to be liberal legislation in the General Mining Act of 1892. Those that wish to invest their money in the Province of Quebec can secure titles and their rights will be respected. (Applause.) There is not the slightest danger that they can be disturbed in their possession. If they wish to commence by prospecting, they can obtain a prospector's or exploring license. If they wish to work a mine on purchase they can do so, and then become absolute owners, provided they work the mine within a given period. We allow, practically speaking, a sufficient quantity of land to be sold to any given applicant, but we desire to prescribe as much as possible monopoly or pure speculation. (Applause.) In spite of many obstacles and difficulties there has been considerable progress made in mining and in the mining legislation of the province. When in 1878 and 1879 I was called upon to exercise the functions of Commissioner of Crown Lands, all we held then in the shape of legislation was simply a by-law containing four or five clauses of the Act of 1879 in reference to phosphate lands. We had also what was known as "The Gold Mining Act of 1864," which referred specially and exclusively to the Chaudière Valley. Beyond this legislation we had nothing and it became my duty then, in 1880, to frame the law which has been known as "The General Mining Act of 1880." In 1882 I ceased to be Commissioner of Crown Lands and in the interval between 1882 and 1892 another piece of legislation was introduced, to which I, of course, do not wish to refer. (Laughter.) In 1892 the present law, "The General Mining Act of 1892," was framed, and I think we may consider it to be a distinct improvement on the past legislation. (Hear, hear.) I am ready to admit that there may be features in that law which are not altogether modern and which might be improved, but in the main its features are in harmony with the times and with the views of your Association. One of the features to which I wish to refer briefly and in a word is the inspection of mines. Up to that date the inspector of mines was a person generally a lawyer (laughter) without the slightest knowledge of mining or the mineral industries. Now the inspector of mines must be a mining engineer of five years standing, having a diploma and a practical experience in mining work. (Applause.) The province has been divided into two great divisions, but there has so far only been one inspector—Mr. Obalski. The province so far has not received enough revenue to warrant me in recommending an additional inspector, but I believe, however, since I have had the opportunity of hearing you refer to the different topics under discussion at your meetings that probably, within a short time, it will be my duty to recommend the appointment of another inspector. The Commissioner then ably reviewed the progress that had been made in mining, mentioning particularly the phosphate deposits of the Ottawa Valley, the iron making industries of Radnor and Grande Piles, the asbestos, copper, slate and building material production of the Eastern townships, and the new discoveries of oil fields in the Gaspe district.

I believe from a national point of view your work is extremely useful and you deserve all the encouragement that can be shown to you. You have been kind enough to say that I was one of the best friends of your Association. I believe Mr. Chairman that you have been too kind in these remarks, but believe me I am thoroughly imbued with the importance of the work of your Association. You are materially aiding the mineral resources of the province, you are inducing foreign capital to come here, and you are entitled to all encouragement. Now Mr. Chairman if it is in the power of the Commissioner of Crown Lands, if it will be possible for him to help your Association, I give the assurance in the presence of the members at this table, that you may rely implicitly upon me. (Loud cheers.)

If I am not interfering on the order of the toasts, perhaps you will permit me to propose here, in my capacity of Commissioner of Crown Lands and therefore General Director of Mines, having as it were under my control in a measure even your Association, (cheers) the toast of "The General Mining Association of the Province of Quebec," and to say that I hope it will be long lived and continue in the good work that you have commenced and are carrying on and for which you are deserving of the thanks of the good citizens of the province. (Loud applause.) The toast having been drunk with enthusiasm, the chairman called upon Mr. B. T. A. Bell to respond.

MR. B. T. A. BELL—Mr. Chairman, Mr. Mayor and gentlemen: I am sure it has been very gratifying to all our members to listen to the excellent address and the kindly words of encouragement from our esteemed Commissioner of Crown Lands, and it gives me great pleasure to acknowledge the toast which he has so gracefully proposed. While it may be true that the secretary of any Association may be regarded as the mainspring of its operations, the pivot, if I may call it, upon which its success depends, is unquestionably the treasurer, and as his well known oratorical powers can more fittingly express the sentiments of the occasion, I have much pleasure in asking Mr. Stevenson to reply.

MR. A. W. STEVENSON—It is very kind of the secretary to speak so pleasantly of my work but my duties are not very onerous. Our Association, in its efforts to extend the knowledge of its members, to distribute information respecting the resources of the province, and particularly to protect the industry from pernicious legislation, has been distinctly successful. The present Government of which the Hon. Mr. Flynn is a member and whose presence we so heartily welcome in our midst, has shown by its recent enactments that it recognizes our rights, which was more than could be said for its predecessor in office, whose mining law was nothing short of common robbery. (Cheers.) Our Association desires to go on doing its duty by the mining industry of the province in a fearless manner, not as supplicants for special favors at the expense of its neighbors, only seeking fair play, and I can tell Mr. Flynn that if as an Association we should ever have to seek for some assistance in our efforts to promote knowledge, it will be a case of necessity, and he can readily grant the request. (Applause.)

Mr. George R. Smith at this stage favored the company with the song of the Association, "Drill ye Tarriers, Drill," the company joining heartily in the chorus.

MR. B. T. A. BELL—We have been honored to-night by the company of two gentlemen who represent very worthily the mining interests of the sister province of Nova Scotia, Mr. John F. Stairs, M.P., and Mr. Graham Fraser. These gentlemen are to be congratulated on the well merited success of their endeavours to establish the iron industry of that province on a basis that is distinctly creditable to the country. Their establishment at Ferrona is probably the largest of the kind in the Dominion and it has been equipped with a plant second to none on the continent. I would therefore ask you to drink success to the mining industries of Nova Scotia.

MR. JOHN F. STAIRS, M.P., in acknowledging the toast, referred to the known wealth of Nova Scotia in her minerals and the steady advancement that had taken place in recent years in the development of the coal, gold, iron, gypsum and other mineral industries of the province.

MR. GRAHAM FRASER—I am very glad to be here but I am very sorry I cannot make a speech—none of our family were every known to make speeches. An uncle of mine, a good Presbyterian, died not very long ago, and his pastor told me at the funeral that he was a very practical man. He could never be induced to pray at prayer meeting. On one occasion the pastor had asked him to pray, and after the meeting my uncle took the minister to one side and said, "Now, look here, I do not want you to ask me to pray in public; there are a lot of fellows around here who do not give anything to the church, let them do the praying." (Laughter.) I could not prepare a speech if I tried to, but I may say that in the way of the iron industry, your chairman read a paper this afternoon that gave more facts and statistics than I could give you now. We have a furnace that turns out about 85 tons of pig per day, and that has been running now for a year. Our steel works are the growth of an industry that commenced on a very small scale twenty-one years ago. Two of us started steam forging, and the business gradually grew until a number of years ago it was turned into a joint stock enterprise called the Nova Scotia Steel and Forge Company. At the present time we employ about 450 men regularly, and at the iron works, of which Mr. Stairs is president, about 400 more. I am very glad to be here, and I cannot do anything further than thank you for the reception you have given me. (Applause.)

Mr. E. D. Ingall and Mr. F. Cirkel here contributed an excellent duet on the flageolet and piano.

MR. J. BURLEY SMITH, in a few appropriate remarks, completed the toast list by giving "The Geological and Natural History Survey," to which Mr. E. D. Ingall, M.E., Chief of the Division of Mineral Statistics, fittingly replied.

The toast of "the Ladies" called Mr. James King, M.P.P., and Mr. W. T. Costigan to their feet, and it need hardly be said that both did ample justice to the subject.

A hearty "Auld Lang Syne" and the National Anthem terminated the proceedings.

Asbestos Mining in South Africa—A London syndicate, styled the Cape Asbestos Company (Ltd.), has been registered in London with a capital of £55,000, in £1 shares, to purchase any asbestos or other mines, quarries, workings, rocks, or lands supposed to contain asbestos or other minerals, in South Africa, Canada, Italy, or elsewhere, to take over and work the Farms Koegas, Hounslow, Schalkdrift; to acquire certain mining rights over the Farm Schalkpretz, all situate in the district of Hay, Griqualand, Cape of Good Hope; and to carry on the business of mining and working for asbestos.

Good News for Ontario !

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The Successful New Process for the Treatment of Refractory Gold Ores at Marmora Ont. Described.

The Walker-Carter process, for the treatment of refractory gold ores, which was introduced about one year ago by the Hastings Mining and Reduction Company, has fulfilled all the claims made for it by its owners. A mill with a capacity of from seven to ten tons was erected in the village of Marmora last spring, and has been in constant and successful operation for the past six months. About 600 tons of ore have been successfully treated, and an average of 85 per cent. of the assay value of the gold recovered, besides which the arsenic in the Mispickel is entirely recovered in a commercial form, as arsenious acid. As this is the first complete plant erected in connection with this process, a description of the operation may be of interest.

The ore is first crushed, then dried and ground to a fine pulp. It is then conveyed to the hopper of the roasting furnace, which is one of the chief features of the invention. The ore is caused to travel over an extended heating surface, entering at the coolest part and coming out at the hottest part of the furnace.

The roaster consists of a series of horizontal retorts, to which the heat is applied externally. Each retort contains a rake shaft with a series of rakes of a peculiar shape, which are moved to and fro in a semicircle, and serve to push the ore from one end of the retort to the other. The ore then slides from the upper retort to the lower, and undergoes the same treatment as before until it leaves the furnace.

On leaving the roaster, the ore is found to be entirely free from sulphur and arsenic.

The arsenic leaves the retorts as arsenious acid, together with the sulphurous fumes, and are caused to pass through specially constructed condensers, where the arsenious acid is condensed, the sulphurous acid being allowed to escape through a chimney. The ore is then conveyed to the amalgamator, where the mercury is applied in a state of vapor. It is then put through a water cooled tube, and falls into the pans, where the amalgam is recovered in the usual way. At present the tailings are allowed to escape, but it is intended, as soon as a concentrating plant is erected, to recover the oxide of iron, which is of considerable value as a paint. The arsenious acid recovered will more than pay for the whole cost of treatment.

The process is continuous, involves no hand labor, and requires comparatively little attention.

Plants are being erected in various parts of the United States for treating sulphurets and for recovering flour gold.

The Hastings Mining & Reduction Co. operate under a license from Messrs. Kitson and Graham, of Philadelphia, Pa., and Alexander Keith, of Toronto, which is confined to Hastings county. The patents for the rest of Canada are owned by Arthur Kitson, of Philadelphia, and Alexander Keith, of Toronto.

The following is a report of the process made by the well known America Mining Engineer, Mr. Harvey Beckwith, formerly of the Comstock Mines, and Mr. Wm. H. Murdock, of Hidalgo, Mexico.

It is claimed that this is the only known process for the successful treatment of the Mispickel and surplur ores carrying gold, and for ores carrying flour gold.

Report of Harvey Beckwilh, Esq., M.E., upon the Hastings Mining and Reduction Co.'s process for treating refractory gold ores.

SIR,—Left this city on 10th of October, arriving at Mamora, Ontario, on Thursday, October 12th. The object of my visit was to examine the Walker-Carter process and mill located on the Crow river, near the above named town. I found the mill in operation, and was informed it had been in continuous operation for nearly five months last past.

This mill consists of an old fashioned Blake crusher, set to crush fine, discharging the crushed ore on to a plate dryer. The dried ore is elevated into a storage hopper, which supplies, automatically, an old style Griffen pulverizer, which supplies the roaster with pulp of fairly good quality. This pulverizer discharges its pulp on a screw conveyor, which discharges into an elevator, the elevator discharging on to a screen revolving in the hopper, which supplies the ore roaster or oxidizing furnace.

The roasted or oxidized ore is discharged from the furnace on a cooling floor, from which it is elevated into the hopper that supplies the amalgamator.

This amalgamator discharges the pulp containing the amalgum into the first amalgam collecting pan, which flows into the second pan, the second pan into the third, and the third pan into the settler, which is constantly discharging the finish or end of the treatment. From the foregoing statement, it will be seen that the ore under treatment goes through six different operations, namely: crushing, drying, pulverizing, roasting, amalgamating and panning and settling.

It might be well to state here that the ore being treated is of a most refractory class, and that heretofore all systems to extract its values profitably, have failed until this mill was built and put in operation.

These ores are commonly known as "mispickel" arsenical pyrites. They carry gold, and hence may be called auriferous mispickel; auriferous arsenical pyrites. They consist of the sulphides of arsenic and iron, with quartz and some magnesian limestone as gangue. To successfully treat these ores, it is not only necessary to recover a good percentage of the gold, but also *condense* the arsenious gasses set free in the roasting furnace. Condensing these gases is successfully accomplished, but I was not permitted to examine how this was done.

The Roaster or Oxidizing Furnace.—I carefully examined the same and its operations, and must say that the ore was discharged perfectly roasted. I could not detect any sulphor or arsenic present. The gold was liberated, and shoved well into the pan. The furnace works automatically and continuously, feeding itself, stirring conveying and discharging the ore. Upon inquiring, I was informed the furnace run right along and was no trouble to manage. The consumption of fuel for 24 hours is ¾ of a cord of hardwood, or 1½ cords of dried slabs.

The Amalgamator—This machine also works automatically and continuously, as also the pans and settler connected with it. The roasted ore containing the gold is fed into this machine for the supply hopper above it.

Attached to the side of the hopper of the amalgamator is a small hopper holding quicksilver, which is fed into ore as it passes into the machine, and so managed as to feed a certain number of pounds of quicksilver to a ton of ore.

In the lower part of the machine there is an ordinary fire-place, where sufficient quantity of heat is generated to *insure* the vaporization of the quicksilver. To prevent the escape of the quicksilver fumes, the cold air above is utilized, and a water jacket condenser serves the same purpose at the discharge end. The machine is very simple, and seems to work perfectly, the gold liberated being amalgamated. In my judgment, the percentage of gold saved is governed by the *finenss* of the pulp. As shown at this mill, it is a very cheap and simple system for recovering gold.

After adjusting the amalgamator, and the water supply for pans and settlers, they run themselves and are no further trouble. I am imformed that the percentage of gold saved averages 90 per cent. of the value contained in these ores, and that the loss of quicksilver comes within an ounce per ton of ore treated. The arsenic saved and condensed as the oxide of arsenic is valuable.

COST OF OPERATING MILL.

4 men at $1.25 per day	$5 00
1 man at $2.00 per day	2 00
Rental and power per day	2 00
Fuel, 1½ cords of slabs	2 00
Oil and lights	1 00
Superintendent	3 00
	$15 00

Present capacity of mill about five tons in 24 hours.

So soon as additional condensers are set up, the capacity of the mill will be about ten tons in 24 hours.

Conclusions—After careful investigation, I state that this "process" is a success. Owing to its simplicity, ordinary people can successfully operate it after a month or two of instruction by a competent person.

Its adaptability, and the field of its usefulness in treating base gold ores will, in my opinion, be great.

In my judgment it will easily and economically treat all classes of auriferous sulphides or gold, in association with the sulphurets of iron and copper.

As to gold very finely divided, such as "float," "flake" and "flour" gold, the system of *dry* amalgamation, as carried out by the amalgamator above described, seems to me, will easily save it. The cost of reduction is greatly lessened, because the whole operation is automatic.

From the foregoing, I can say I do not know of any process or system of extracting gold from its ores that can compete with the method, and therefore most heartily and sincerely recommend it.

(Signed) HARVEY BECKWITH, M.E.

Having recently visited and carefully examined and tested the results produced by the Walker-Carter gold mill located at Marmora, Hastings County, Ontario, Canada, in treating the very base, and refractory gold ores of that section, namely, arsenical pyrites.

I endorse unreservedly the report herewith attached of Mr. Harvey Beckwith, M.E., made by him recently on this mill and process, as being conservative and fully within the results produced, as I believe, for the past five months.

While the perfect oxidization of these ores, and the subsequent amalgamation of their gold contents to a high per cent., is unprecedented so far as my knowledge goes, the condensation of the poisonous arsenical gases from the roasting and the utilization of them as the commercial oxide of arsenic is something never before accomplished in a continuous operation.

Another point strongly attracted my attention, and that was that the men running this mill had never had any previous experience, but had been taught by one of the inventors in a couple of months.

(Signed) W. B. MURDOCH,
Murdoch Tunnels, Hidalgo, Mexico.

MINING NOTES.

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[FROM OUR OWN CORRESPONDENTS.]

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Nova Scotia.

Caribou.

The mines and property of the Truro Gold Mining Co. were sold at sheriff's sale, on the premises at Caribou, on the 16th of the month to George W. Stuart, acting for the company. It is said that the property will be reopened next summer, and the shaft sunk to the pay chute.

Isaacs Harbor.

The protracted litigation over the Hurricane Island mine continues to keep this district dull. The work at the North Star mine continues, but the results are not as large as during the summer.

The Richardson mine continues to keep up its record, and is now regarded as one of the standbyes of the province. In places the vein has had a width of 20 feet, and maintains an average width of 10 to 12 feet. During the year ten additional stamps were added to the mill, and further additions to the mill plant are contemplated in the spring.

Montagu.

On the morning of the 28th of December the worst disaster in the history of gold mining in Nova Scotia occurred in the mines of the Symon-Kaye Syndicate of this district. A pair of men were at work in a stope rising from the back of the 100 ft. level east at a point about 80 ft. east of the shaft; at eight o'clock they fired their hole, warning the men at work driving in the levels. The shot blew a hole in the wall intervening between the new workinge and the old, letting in all the water above that point, flooding the mine and drowning the two men driving the level west, one of the men driving east and the man mucking quartz. Four other men at work in the same shaft escaped.

The coroner's jury returned a verdict of accidental drowning, but recommended that the legislature furnish the inspector of mines with sufficient means to procure plans of all underground workings.

[We comment on this accident elsewhere.—ED.)

South Uniacke.

The Thompson-Quirk mine has reached a depth of about 260 feet, and the vein is reported as rich as ever, but to have separated into two or three parts.

A local syndicate or company has been organized in Halifax to take over the mining areas lying immediately east of the Thompson-Quirk property. The syndicate will sink a shaft near the dividing line to cut the Thompson roll, the distance to be sunk being estimated at about 350 feet. Mr. A. A. Hayward, one of the vendors, is in charge of the work, which has already been commenced.

Renfrew.

The advertised sale of the C. H. North properties did not come off on the 27th December. Instead, an arrangement has been made by a syndicate (composed of Evan Thompson, Charles Thompson and D. A. Macdonald) to pay off the indebtedness, aggregating about $5,000, and take over the mine and appurtenances, Mr. North to have nine months in which to redeem the property. Further conditions and stipulations are in the agreement, and if carried out this district will once again come to the front as a producer.

Waverley.

For the first time in twenty-five years the product of this district has reached the 2,000 oz. mark. Since 1868 there has been no year when the product was in excess of 2,000 ozs., and since 1877 the annual production has been less than 500 ozs. The total for 1893 has been entirely the product of the West Waverley Gold Co., Ltd., and amounts to 2,108 ozs.

Quebec.

Templeton.

It is reported from a reliable source that the Amsterdam mine (De Nederlandsche Phosphaat Maatschappij) will entirely abandon their phosphate mines in this district which are equipped with a large machinery plant, boarding and dwelling houses.

The Wallingfordt property is turning out large quantities of good sized crystals daily. The veins, eight feet wide, continue in regular width to the depth and in the horizontal. Eight men are steadily employed in the mine; five men are trimming mica for a Boston electrical concern. This mine is considered by experts to be the richest mica mine in the township of Templeton up to date.

Mr. A. Pullan, from Montreal, is working the Perkins property, lot 18 in the 8th range. The mica deposits so far discovered are reported to be very promising. Five men are employed.

Mr. Hotchkiss is working with nine men on the south half of lot 14. Considerable quantities of mica have been taken out of different veins, but no particulars are to hand.

Negotiations are pending with English people re sale of the Ferguson lot 4 in the 9th range. This property shows four large deposits of mica, which were worked with success in the summer of 1892.

Eastern Townships.

We learn that work has been resumed at the Albert copper mines, Capleton.

Ontario.

Lake Nipissing.

The white mica mine of Mr. John Mackay, Lot No. 9, 1st Concession, Township of Calvin, is meeting with great success in the depth. The original vein of a coarse granite had on the surface a width of about 5 ft.; this vein has been followed by a shaft to 20 ft. depth, and it was found that it widens out gradually to a width of 14 ft., the horizontal extensions being of regular character. The crystals are of a greenish color, containing occasionally dark spots, probably tourmaline, but it has been observed that towards the depth these spots seem to disappear. Further development work will show whether this will be verified. The daily average output amounts to 150 lbs. of perfect crystals. This mica is now being trimmed, and averages 20 to 25% of 2 x 2 up to 3 x 5 and over.

Sudbury District.

We are pleased to learn that the Drury Nickel Company commenced operations again on the 2nd inst. under the direction of Mr. R. P. Travers, liquidator, with a force of thirty men, after being closed down for several months. The men are to be paid all arrears of wages on the 20th. This is a bit of good news.

The plans have been prepared and work will soon commence on a new vertical shaft in the Copper Cliff mine, as the present inclined shaft runs away from the principal ore beds.

Fifty men were laid off through the Evans Nickel mine shutting down at 11 p.m., 23rd Dec., on account of cold weather, and to enable Capt. Davis to have the main shaft cleaned out for the purpose of putting in the diamond drill to test for ore below the fifth level.

British Columbia

Slocan District.

The Nelson and Fort Shepherd Railway began running a regular train service about the 20th December. Both the Revelstoke and Bonner's Ferry routes had been closed by ice some weeks before and the Northport and Robson route was also blocked some few days before the N. & F. S. opened.

There is now uninterrupted connection with the outside world, and ore is being shipped regularly.

From December 21st to January 10th 1,511,172 lbs. of ore were shipped from Kaslo to the smelters in the States.

The sleigh road from the mines to Kaslo has been in fine condition and about 45 to 50 tons of ore are arriving daily at the wharves in Kaslo for trans-shipment to the States.

The Freddie Lee, Mountain Ch[illegible], Noble Five, Idaho, Washington, Rico, Blue Bird, Dardanelles, Antelope, Slocan Star, Northern Belle and several others are all winning ore.

The Surprise claim was sold to a Mr. Ferguson of Chicago, for $60,000; one-half cash.

Notice has been given that application will be made to the Legislative Assembly so as to permit of the Kaslo-Slocan Railway being constructed with a narrow guage.

Notice has also been given that an application will be made to incorporate another company to build a Kaslo-Slocan railway. This is virtually the C.P.R., and it will be a fight as to who will control the Kaslo route, the Great Northern or the C.P.R.

The clearing of the right-of-way for the Kaslo-Slocan Railway is in great part finished and the company's agent at Kaslo has publicly and emphatically stated that the line will be in running order by August 1st.

Everything outside of the mines is quiet; everybody is waiting for the spring. The ore shipments are making a good impression on outsiders and money is already looser.

Nelson District.

Mr. J. J. Jordan, M.E., the new manager of the Hall Mines (Ltd.), has arrived at the mines. He has been employed in a gold mine near Cape Coast Castle, in the gold coast, W. Africa, also in mining in Mexico and Spain.

Matters appear to be jogging along very well up at the Silver King. There are at present some twenty-five or thirty miners at work, in addition to the surface gang. All of the underground work has so far been done by contract, and judging by the reports, those who have taken the work up have done very well. The contracts, which are nearly all along the line of development work, are let by the foot, and can be terminated any time the management considers a sufficient amount has been done in that particular direction. The work up to date has given the most satisfactory results. The main lead has been uncovered at various points for 2,000 feet, and so far the greatest part of the work has been done in ore. Nothing in the nature of a well defined wall has as yet been located, though it is expected that these will come as depth is gained. The work has opened the mine in excellent shape, and several hundred miners could be put to work at any time in the future that the company may think best. Drifting has been done each way from the winze that connects the upper and lower levels. These drifts are forty-five feet long and are in solid ore. Two new contracts have been let to carry on this drifting to some further extent. There is a tunnel in about sixty feet near the line between the Silver King and the Kootenay Bonanza, which shows good ore, as does the fifty-foot shaft sunk on the Bonanza. About thirty feet lower down than the mouth of the lower level, a shaft has been sunk from which ore is being taken out. Of the old levels, the upper one is in 240 feet, and the lower one must be in nearly 700 feet. There is an incline connecting the upper level with the surface, and a winze connecting the two levels. The greatest depth is gained in about 300 feet below the surface. A portion of the work will consist of stoping out the ore between the two main levels. The surface gang is busy cribbing up an ore dump, in which this output will be put until sorted for shipment. At present the ore is being sorted quite closely as it is broken down and will require but little more handling before being sacked. From present indications the desire is to get the mine in shape for the working of a heavy force of men when the tramway is constructed.

The trustees of the Nelson Hydraulic Company have unlimited faith in the gold producing nature of their property. They have determined that the spring will find them in a position to commence working, although all the preferred stock offered for sale has not been disposed of. With this end in view they have purchased some 80,000 feet of lumber for the flume, sluice boxes and building. The lying timber on either side of the flume is being cleared for a total width of seventy feet, to prevent accidents by fire or falling timber.

Trail Creek District.

Early in the season private parties started and the Government completed a wagon road from the town of Trail to the mines, seven miles in length. It was built on business principles, and though costing but $3,000 is a good road. The first heavy freight hauled over it was a boiler, engine and Burleigh drill for the War Eagle mine. Ten thousand dollars were spent, or misspent, on that property, and the result was two long tunnels without ore, and the company dropped the bond. During the fall the same company, or part of it, again took hold of the property, and under proper management a continuous ore body, 8 feet wide, carrying $40 in gold to the ton has been found and followed. A small force is working and will work all winter.

In the early part of the year the shaft on the Le Roi was extended to a depth of 200 feet. During the summer levels were run from the bottom of this shaft 70 feet each way on the vein, exposing a large ore body of better quality than at the surface. Water coming in too freely to handle with windlass, the mine was allowed to fill up. During the fall the company commenced shipping the dump and some surface ore, and the results were so good that hoisting and pumping machinery were put in and winter supplies laid in for thirty men and three teams. It is the intention to both sink and drift and to ship ore extensively all winter. Up to date the shipments aggregate 250 tons.

A bond was taken on the Josie by some Spokane parties early in the summer, and about $4,000 was spent in exploiting the property. They had varying success, but at the end had a nice vein of very good ore. Owing to the financial stringency the work was stopped. Sixty tons of the ore were shipped early in December, and on the returns depends its future as a shipping mine.

On the Nickle Plate 50 feet has been sunk under the difficulties of lack of money and abundance of water. The vein is a small one (about 18 inches wide), but carries the richest pyritic ore in the camp, averaging $115 in gold per ton. One carload of the ore was shipped early in December, but the returns have not yet been received. The owners propose to work a small force all winter.

Two men worked steadily all summer on the O K, and the result is a tunnel about 150 feet long and an uprise of about 70 feet. The vein is a continuous one and the ore all good, with some spots of marvellous richness. This vein has been developed, and the owners supported by a hand mortar, about $4,000 being " milled " in the mortar during one week in September. On the dump there are about 250 tons of ore, which if the weather allows, will be shipped this winter to the Tacoma smelter. There are many new and odd combinations of ore in this mine, namely, free gold with copper pyrites, free gold in massive galena, free gold in zinc blende, and occasionaly a combination of them all with a dot or thread of native silver. What this vein may carry at a great depth is beyond the knowledge of the experts, but all are unanimous in the belief that it would be a good thing to have in the family.

Fort Steel Division.

The season of 1893 has shown a marked improvement in the number of prospectors and the number of recorded locations. The claims compare 42 in 1892 against 175 in 1893. Free miners' certificates, 78 in 1892, against 284 in 1893. The shut down of many of the mines across the border deprives many of the prospectors who come in here of making a grub-stake this winter; but in the near future we hope to have mines of our own, where men can get grub-stakes to prospect in the country they work in.

The season's placer mining has been much the same as of late years. The Chinese on Wild Horse Creek have seemingly made the same amount of money, and the usual contingent left for China. The claims owned by Mr. Griffith were bought from him this summer by an English company. This syndicate put in good machinery and ran the claim all the summer under the management of a competent hydraulic miner, Mr. Beaston of California. The company had a lot of trouble getting the claim in shape to work, the former owners seemingly having allowed the claim to run itself, and the summer's work was chiefly making sluices, laying pipe and clearing room to pile boulders in the future. The clean-up was fairly good, and fully justified the supposition that the claim, fixed up as it is, with a good go-ahead summer's work, will fully justify the shareholders in their outlay of capital. We should judge that the clean-up of the various companies would amount to $30,000. On the Moyea river there are about ten men working, who seem to make enough out of the ground to buy whiskey with anyway. An application has been made by A. W. McVittie for a lease of ground on Palmer's bar, the idea being to bring on water from the Moyea and to run the fine gravel on the bar through an hydraulic elevator. This scheme should be a good one, as the outlay on the ditch would only be about $5000, and there are at least 100 acres of gravel on which the Chinese make from 25 cents to $1.50 a day.

Vancouver Island.

The shipments of coal for last year, notwithstanding dullness of trade in American markets, show a substantial increase over former years. The figures are: New Vancouver Coal Co., 1893, 388,649 tons, against 375,834 tons in 1892, or an increase of 12.815 tons; Union Colliery Co., 1893, 126,438 tons, against 93,826 tons in 1892; Wellington Collieries, 1893, 312,573 tons, against 276,118, an increase of 36,455 tons. The East Wellington Colliery for a portion of the year was closed, but its shipments were between 15,000 and 16,000 tons.

Miscellaneous.

The shipments of gold dust from this province, as reported by Wells, Fargo & Co., show a decrease compared with 1892 of $26,349.92, the figures being as follows: 1893, $302,340.57; 1892, $328,690.49.

The Consolation placer mine on the Big Bend averaged last season about $12 per day to the man, and the output is reported to have been over $20,000.

Watertight Shaft Walling with Stone Cribs.—At the Government colliery at Osterwald, in Hanover, sandstone rings made in 10 segments have been used for a deep sinking instead of cast-iron cribs. The joints are wedged with wood. These stone cribs are considerably cheaper than cast iron ones.

Tensile Tests of Winding Ropes. — A. Kàs, *Oesterreichische Zeitschrift fur Berg-und Huttenwesen*, has experimented at considerable length with different kinds of winding ropes, the ropes being either (1) new, (2) old but unfrayed, or (3) frayed, this last class being again subdivided according to the position of the broken strands. The experiments showed that the tensile strength of the rope was not, as is frequently supposed, diminished by the twisting together of the different strands, but that the opposite was the case, the tensile strength bei g slightly increased.

CANADIAN COMPANIES.

Boston Bar Gold Mining Company has been formed, with headquarters at Vancouver, B.C., to obtain by purchase or otherwise, and to hold at or near Boston Bar on the Fraser River, British Columbia, mines or minerals, and to carry on the business of miners of every description. Authorized capital, $50,000, in shares of $10 each. The directors are: Daniel R. Young, Vancouver; A. F. Griffiths, Vancouver, and Wm. R. Robertson, Vancouver.

British Columbia Mining and Manufacturing Co. has been formed with a capital of $100,000, to purchase from Hubert Kossuth Lee all rights, patents and privileges now owned or held by him in connection with certain mining machinery, and to manufacture and sell the same and to carry on the business of manufacturers of and dealers in all kinds of mining machinery; also to acquire mines and to carry on the business of miners. Head office: Vancouver. Directors: Wm. Ritchie Robertson, A. F. Griffiths and D. R. Young, Vancouver; H. K. Lee and Donald McPhee, Montreal.

Northern Belle Mining Company has been registered at Victoria, B. C., with an authorized capital of $250,000, in shares of $10 each, to carry on the business of mining and milling. Canadian office, Kaslo, B.C.

Victoria Chemical Co., Ltd., has been registered at Victoria with an authorized capital of $100,000, in shares of $50, and headquarters at Victoria, B.C., to acquire and take over as a going concern the business of chemical manufacturers, now carried on by John W. Fisher, J. A. Hall and Frederick Moore, under firm or style of Victoria Chemical Company, and to carry on the business of manufacturers of muriatic, sulphuric, nitric and mixed acids, explosives, chemical manures, sulphate of copper, sulphate of iron, nitrate of lead, soda crystals, bi-carbonate of soda, alum, and all kinds of chemicals, the chemical treatment of copper and other metallic ores, and the distillation and treatment of coal tar.

Pacific Brick Company (Ltd.)—Capital, $20,000, in shares of $20. Canadian office: Vancouver, B.C. Directors: Charles A. Beals, James Stokes, George Hartley, Vancouver. Formed to carry on the business of manufacturers of brick, tile, terra cotta, sewer and drain pipe and pottery, etc.

The Victor Gold Mining Co. of Gold River is applying for charter of incorporation to acquire certain gold mining property at Gold River, near Chester, Province of Nova Scotia. Directors: J. T. Burgess, A. G. Cunningham, Walter G. Brookfield, Geo. S. Campbell and A. N. Whitman.

The Kootenay Hydraulic Mining Company was the first to acquire placer ground in the Pend d'Orielle section of the Nelson mining division of West Kootenay. The first claims (three in number) extend from the Columbia river up the Pend d'Orielle river for a distance of a mile and a half. Afterwards other claims were leased, and now the company controls all the ground on the north side of the river as far up as the mouth of Fifteen-mile creek, or a total distance of nearly fifteen miles, following the sinuosities of the river. The company first put in a saw-mill to cut the lumber required for flumes, then built a wagon road over which to haul the lumber. A shaft was sunk on one of the claims to a depth of 100 feet without striking bed rock. Several tunnels and drifts, as well as prospect shafts, were also run or sunk, in all of which, without exception, gold was found. The wagon road runs from Waneta, on the Columbia, to Twelve-mile creek. From Twelve-mile creek to Fifteen-mile creek the road is but six feet wide.

A flume was built from Sixteen-mile creek to the bar at the mouth of Fifteen-mile creek, where the company made the first attempt at hydraulicing. By the time the pipes and pressure-box were gotten in place the season was so far advanced that the water supply was so low that the sluicing could not be carried on to advantage. Everything, however, is in shape for the high water which is sure to come in March. The returns were so good that the company erected a commodious building for a permanent camp at that point.

Work is now progressing at Seven-mile creek, where two pressure-boxes will be put in, so that Brown's bar can be worked at two different points. By the time the snow disappears there will be ample water, as it is brought from both Seven-mile and Nine-mile creeks. A large house has also been erected at Seven-mile creek for a permanent camp, and the headquarters of the company will be there from this time on. Other necessary buildings, like blacksmith shops, ice houses, and stables, have also been erected there. During the fall, when the water was very low, a little sluicing was done at Seven-mile, and the returns indicate that the gravel is rich.

The Kootenay Hydraulic Mining Company has already expended nearly $80,000 in developing its ground, and during the coming spring a large force will be employed in bringing water from the main Salmon river. This will require the building of a ditch from Sixteen-mile creek to Salmon river, a distance of between three and four miles. When the work is completed the water supply will be ample for sluicing every month in the year, while now the creeks supply only enough to work about four months.

Gold and Silver Mining in British Columbia in 1893.

The past two years have witnessed a renewal of interest in the alluvial deposits of the Province, and especially those situated in Old Cariboo. Here hydraulic mining on an extensive scale with modern appliances has been introduced. On the Quesnelle Forks, in the horsefly country, and on the creeks surrounding Barkerville much capital has been invested in the opening up of new claims. During this winter hundreds of tons of hydraulic pipe are being hauled to carry the water to the "giants" that will tear down the banks and wash the gold. At Slough creek large engines and pumps have been placed for the purpose of sinking the shaft to bedrock, now the surface water drain has been completed. It is beyond speculation that in all these sections good results will be obtained, for previous prospecting has developed the presence of good pay. Cariboo is undoubtedly the most attractive field for hydraulic mining on the continent, and those who know the district well believe that in a few years the output will be climbing up to the total of its best former record. There is plenty of ground remaining for development, and veteran Caribooites believe that energetic prospecting would discover virgin fields perhaps as rich as those which were worked in the old days. With the completion of a railway into the district the chances are that prospecting of the country north and east of the famous Barkerville district would be renewed, and many important discoveries made.

In the Cassiar, Omineca and Yukon districts there are many streams that would pay good wages with cheap and rapid transportation near at hand and cheaper supplies to be had. Several of the old bars and benches of the Fraser, east and north of Yale town, are being opened by hydraulic and other methods. Placer mining is still being carried on in the Granite Creek, Kettle River, Big Bend and Bridge River districts. On Vancouver Island, on the west coast, several creeks pay small wages. Another attempt is being made to work the black sand deposits on the beaches of the northeast coast of Vancouver Island.

Outside of Kootenay district, little is being done to develop the gold quartz ledges except the work on the recently discovered ledge in the Alberni district at the head of China creek. It will shortly be known whether this field will prove a profitable one. The great cost of supplies and labor in the Cariboo district has hitherto prevented capital being expended there, as the ledges so far prospected do not carry gold in rich quantity.

The year just entered on gives promise of being a memorable one in the mining of gold and silver in British Columbia, for profitable results will give confidence to capital, and investments in the various branches of the industry will be made on a scale hitherto unknown but long sought. During the year past the resources of British Columbia have received a valuable addition by the developments which have taken place in the mining regions of the Kootenays. As might have been expected, the greatest amount of work has been done in the Slocan lead-silver region. The promise, of better transportation facilities early in the spring served as a stimulus to production and development, and as a result the tally sheet for the year shows some very encouraging figures. From about twenty producing properties in the Slocan the customs returns for the year show that ore to the attested value of nearly $125,000 was sent out to the various markets of the United States. In connection with this output must be considered the fact that some $50,000 worth of ore has been mined in addition to that shipped. This was taken out during the summer and fall and left on the dumps until the opening of sleigh roads afforded easier and cheaper means of transportation. At Kalso from 600 to 700 tons of ore were piled on the wharves awaiting the opening of the Nelson and Fort Sheppard railroad.

As an example of the wonderful richness and extent of some of the leads in the Slocan country may be cited the Slocan Star. On this property recent discoveries have resulted in placing in sight, according to the estimate of an expert, some 12,000 tons of ore which should net the owners over $100 per ton. A number of other properties have showings of ore ranging up into the hundreds of thousands, and most of the smaller are looking well and showing up more or less ore. Several companies interested in transportation have had estimates made by experts with a view to ascertaining the probable daily output of this section under favorable circumstances. The lowest figures which have resulted from these inspections are 350 tons daily for a period of 18 months to come. When it is remembered that the sworn values on the Slocan output, made for customs purposes, run to an average of over $150 per ton in lead and silver, some idea may be formed of the great wealth contained in this section.

At Ainsworth a considerable amount of development work has been done and several good shipments have been made, chiefly from the "No. 1." Among the recent discoveries at this point may be noted a strike of 8½ feet of clean galena on the Little Phil and Black Diamond.

The Toad Mountain District maintains nearly the same position held at the first of the year. The Hall Mines Company has taken the Silver King properties in hand, and a force of men are now engaged in development work which will enable the company to put on a big force of men in the spring. A tram line will bring the ore from this property down to Nelson for shipment. There are a number of good claims on the mountain, which may be expected to go ahead under the stimulus of a big producer in the vicinity.

On the Salmon river and its tributaries, and along the Pend d'Oreille river, a considerable amount of placer and hydraulic ground has been taken up by various companies during the year. Enough work has been done on these to demonstrate beyond a doubt that placer gold in paying quantities can be found all through that portion of the Kootenay country.

In the Trail Creek section the character of the ore changes to a considerable degree, and a sufficient amount of gold is found, in connection with other metals, to defray the working expenses. The Le Roi and other claims in this district sent out about forty tons of ore per week for some time during the fall.

In the Duucan river country the results have not been so satisfactory. Owing to its remoteness from transportation facilities, and the difficulties in the way of prospecting and development, but little was done in this section during the year. There is no doubt but that the district is extensively mineralized, and future results may prove more satisfactory.

The Lardeau and Trout Lake section of the Kootenay has made good progress during the year. The majority of the claims in this part of the country have yielded very encouraging returns for the amount of development work done. In several instances sufficient capital has been secured to open the leads in proper shape. The Black Prince and Silver Cup, two of the best claims, are in good hands, and a force of men will continue to work them all winter. A number of miners turned their attention to placer diggings in the Trout Lake country, when the slump in silver came, and enough work was done along this line to make the fact plain that placer gold exists there, but whether in paying quantities or not remains to be demonstrated.

In East Kootenay very material progress has been made all along the line. Old claims have been developed with good results, and a number of new and favorable looking locations have been made. The ores of this section while not of such high grade as those further south and west, appear in strong, well defined leads, which give every indication of permanency.

Generally speaking, the year 1893 has demonstrated that this portion of British Columbia contains vast areas of valuable mineral deposits which will from now on add a steady and ever-increasing stream of wealth to the output of the Province.

A Primitive Smelting Furnace.—Robert Peele, jr., (*School of Mines Quarterly*) describes a primitive smelting furnace in use by the Indians of Central Bolivia, for smelting silver ore. It is called in the native Quichua language "Huairachina," meaning literally a place where the wind is utilized. It is built of fire-clay, is usually from 30 to 34 inches high, and has an irregular oval cross-section, the inside dimensions being 4 or 5 inches by 8 inches. The inside height, from the bottom of the hearth to the edge of the open top is generally not more than 26 inches. Near the bottom of the furnace there are two main fire openings with wide lips, placed opposite each other on the longer sides of the oval, each six inches wide by three inches high. On one of the shorter sides, and a little below the level of the large holes, there is a smaller opening 2½ inches dia. which serves as a tap. Ranged above the fire doors are three rows of 2 by 2½ inch air holes on each side of the furnace, and below each of these is moulded a small lip of clay. The first row from the bottom comprises four holes, two on each side: in the rows above there are three holes on a side, all being placed symmetrically and exactly opposite one another. It is usual to set the furnace on a rock or built up base, 15 to 18 inches above the ground, and in such a position that the air holes on the two sides are in the direction of the prevailing wind. No artificial blast is employed; the average Indian has time enough to wait a favorable wind. The fuel used is a good quality of charcoal charged in alternate layers with the ore in the proportion of about 1 to 1. The materials treated are galenas, as well as zinc-blende and pyritic combinations and those containing the high grade sulphides, such as ruby silver, gray copper, silver sulphide, etc. Argentiferous galena is smelted without flux, and is itself used as flux for the other base combinations or dry ores, by mixing with the latter. The proportions vary greatly, without much regard to regularity of working, though the galena generally forms about 50 per cent. of the ore charge. The main point with the Indian is that his flux shall run well in silver so that when he has sufficient galena at hand he loses nothing by a generous admixture. High grade galenas are much prized, and are often transported long distances to mix with the more intractable sulphurets. In the absence of galena "asendrada" is used for fluxing; this is an impure litharge obtained from the native cupelling furnaces and also carries some silver. In preparing the ore for the furnace it is broken pea size and well mixed with the flux. This would, says Mr. Peele, appear to be a very crude method of smelting but upon the whole, the results obtained are fairly good and attest the skill of the native operator. Samples taken from old slag piles often run as low as 6 to 9 ounces of silver per ton, though assays have been known to be as large as 30 ounces. It must be remembered that the capacity of the furnace is extremely small, say from 50 to 150 pounds of ore in twelve hours, depending upon the force of the wind and the tractability of the ore, and that, therefore, only rich, carefully selected material is worked.

In 1545 the Cerro Rico de Potosi (Rich Mountain of Potosi) was discovered, about 30 miles from Porco, and the Huairachina was immediately introduced, forming for years the chief means of extracting the silver from the ores of these wonderful mines. It has been estimated that, between 1545 and 1572, not less than $250,000,000 worth of silver was produced at Potosi from these furnaces. But, as the rich surface ores were exhausted, the little wind furnace had to give place to the amalgamation process.

The Indians about Porco, who still adhere to its use, make a scanty living, either by working stolen ores or by sorting over and re-sorting the old waste dumps of the mines which formerly were so productive. With infinite pains and labor they collect small bits of good mineral which have escaped attention, or which, attached to large pieces of barren rock, may have been thrown upon the dumps as worthless.

Progress Made in Coking.—Mr. R. de Soldenhoff, *(South Wales Institute of Engineers)*: The writer reviews the state of manufacture in the past and refers to the progress realized under two heads, one refering to the improved article to be produced, and the other to the economy in manufacture. Referring to the first, what had been done generally was to reduce the coal in size, or in other words to crush it, or to separate the smallest of the coal—that is to say, such as would pass through a screen with holes of ⅜ of an inch in diameter and downwards—from the larger coal, and to use only the finest for the manufacture of coke. The question which was not perhaps absolutely settled was whether it was necessary to disintegrate the coal to the state of powder in order to produce good coke. His own view of the matter was that as long as the bituminous coal was in a granular state not exceeding ⅜", it would produce equally good coke as when it was ground to a powder. It was well known that coal in a powdery state, when dry, wasted considerably by being blown away from the trams, and through the charging holes during the charging of the oven, more when charging the coppée ovens. There was no doubt also that the yields in coke were lower with very finely crushed coal than otherwise. In most cases in the present practice the small coal had to be washed with a view to obtaining a good coke. The principal object of washing the coal was to separate the impurities from it in the shape of shale and pyrites. The washing machinery was very efficient, and it was not an isolated case to see very dirty coals producing good clean coke. It should be stated also that the washing processes, so far, had not been as successful in eliminating the sulphur as they were in eliminating the dirt. In sulphury coals—that was to say, coals containing from 1·5 to 2 per cent. and above of sulphur—only a small portion was eliminated, say from ¼ to ½ per cent., in the process of washing, which at first sight appeared strange, because the specific gravity of the pyrites was at least four times that of coal. The real difficulty experienced in eliminating the pyrites was in consequence of friability and mode of cleavage. The pyrites divided into small flattened little specks, which, owing to the law of copolarity, float on the surface of water, and therefore were carried with the washed coal. The writer then enters at length into the second point of improvements realized, namely, economy, which could be obtained in four ways:—1st, To reach a higher daily, weekly or yearly make; 2nd. To attain the highest possible yield; 3rd. To reduce the cost of making the article; 4th. To utilize the bye-product, or in other words, to utilize the surplus gases, etc., escaping through the chimney. As to the yields of the various ovens he quoted statistics showing the result of the yearly working of coppée ovens in comparison with Welsh ovens. The average quantity of coke made in 72 coppée ovens for a year showed 1,039 tons weekly. In 172 Welsh ovens, the average quantity made was 1,080 tons weekly, or nearly 6 tons 6 cwt. per oven per week for the Welsh ovens, and 14 tons 9 cwt. per oven per week for the coppée ovens. With coppée ovens at Ebbw Vale some ten years latea the comparative results were as follows :—

	Make per week, per oven, Tons. Cwt.	Yield. Per cent.
Coppée ovens..........	11·15	63·53
Welsh oven............	6·3	58·99

Looking at these results it was found that the weekly make of the coppée ovens was nearly double that of the Welsh ovens, whilst there was a difference in yield in favor of the coppée ovens of from four to five per cent. Comparing the mode of working the Welsh, beehive, and coppée ovens, it was evident that the coppée oven was the cheapest to work, and it would be sufficient to say, by way of comparison, that the cost of labour in connection with coke-making in the coppée oven in many places was on an average from 5½d. to 8d. per ton of coke. The beehive oven was the most expensive on account of the mode of taking the coke out of the oven by hand. As to the fourth point—the utilization of waste gases, viz., *(a)* the generating of steam by applying waste gases to the boilers; *(b)* the collecting and extracting of the bye-products—we hope to refer more fully in a future issue.

Test Chamber for Showing and Measuring the Indications Given by Gas Testing Apparatus.—Prof. Clowes *(South Wales Institute of Engineers)* describes an improved form of test chamber. It is a wooden box about 20 inches on the edge and made gas-tight by running melted parrafine wax over the surface and joints. The front has a plate glass window, let in at a convenient height for observing a safety lamp or other form of testing apparatus. At the top and bottom are large square openings, closed by zinc trays in a water-seal; these serve for introducing the testing-apparatus, and for renewing the fresh air within the chamber. A light flat board hangs from a bar pivoted in the right hand top corner of the chamber; this board, when swung by means of a handle on the outside, produces a rapid and thorough admixture of air and gas when gas has been introduced into the chamber. There is a small opening above for introduction of gas into the chamber, and a similar opening below for the escape of the air displaced by the gas.

When a mixture of air with a known percentage of gas is to be prepared in the test chamber, the requisite volume of gas is forced into the chamber from a gas-holder. The required quantity of gas is secured by pouring from a measuring vessel a volume of water, equal to that of the gas required, into the top of the gas-holder. This water displaces the requisite volume of gas from the holder, the light gas passing by a flexible tube into the upper part of the chamber. The heavier air escapes from the bottom of the chamber by a small outlet trapped with water. The air and gas in the interior of the chamber are then thoroughly mixed by swinging the mixing-flap for a few seconds. The lamp to be examined is introduced by opening for a few seconds the large aperture at the bottom of the chamber, and the flame-cap can then be carefully examined and measured by observing it through the window. It has been found that a considerable number of observations on different lamps may be made without material alteration of the atmosphere occurring.

The chamber is of exactly 100 litres capacity, and the measurement of the gas for the percentages is therefore simple.

The chamber is mounted on legs, which raise it when it is standing on an ordinary bench or table to a convenient height for observations. It is colored dead black inside to facilitate the observation of pale caps, and is used in a perfectly darkened room, or by covering the head with a black cloth as when using a photographic camera. It renews its atmosphere in the course of two minutes if simply allowed to stand with the large apertures above and below open; this time is much lessened by swinging the mixing-flap while the apertures are open. The mixing-flap has recently been cut away in front, so as to allow the lamp to be introduced before the gas is admitted to the chamber and the mixing is affected; this is found to be unnecessary in practice, as it does not affect the result arrived at; but it is frequently convenient to run through a series of tests with different percentages without removing the lamp from the chamber.

By means of the test-chamber the author has made numerous comparative experiments to test the relative delicacy of different forms of gas-testing safety-lamps. He has also tabulated their indications. Mr. Grundy has similarly examined and tabulated the indications given by Liveing's Electrical Indicator by means of the test-chamber; and other inventors have applied it to the examination of special forms of gas-testing apparatus. The chamber has uniformly proved itself most convenient for these purposes, and has worked with entire satisfaction and perfect ease. It is undoubtedly of advantage to place one at centres where those engaged in gas-testing may not only verify the indications of their gas-testing apparatus, but also accustom themselves above ground to the appearance of different percentages of gas as shown by the testing apparatus. The chamber has hitherto been made of wood, with detached legs for convenience in packing and in travelling. Messrs. W. J. Fraser, 98 Commercial Road East, London, are now preparing a chamber in metal, which will naturally be more costly but also more durable.

Modern Formation of Veins of Pyrites.—Dr. Fleitmann *(Chemikerzeitung VI. 47)* has made the following interesting observations: A covered, brick built cesspool has been lined with a coating of red clay in order to make it water-tight. This plan answered well only for about two years, after which it failed, and the cesspool was abandoned. It was then found that the clay, formerly red, was quite white, and in all directions intersected by veins of compact pyrites of 1 to 4 millimetres thickness. The iron peroxide, through the action of the ammonium sulphide of the sewage, had been transformed into iron sulphide, which, through molecular attraction, had accumulated in these veins.

The Relative Value of Charcoal and Coke in Blast-Furnace Practice.—E. Belani *(Stahl und Eisen.)* points out that in order to estimate the working value of a fuel in the blast-furnace the cubic contents of the zone of combustion must be taken into consideration, as well as the rapidity of the combustion; as the greater the quantity of heat which the unit of fuel produces when burnt in the unit of time, the less will be the loss of heat in the same period, and the greater will be the quantity of heat which will be available for absorption by the charge. Consequently, with different fuels, the least quantity required for a given purpose will fall to that one which, in the unit of time, develops the maximum quantity of heat.

The heat developed by the unit weight of fuel in the unit of time depends (1) on the size of the surface exposed to the action of the blast, and (2) on its relative combustibility. This latter depends on the state in which the carbon is present, and is in inverse, though undetermined, ratio to its specific gravity. Further, the more combustible a fuel is, the more of it will be burnt away in a given time, and the greater will be the surface exposed to the blast during that period; consequently, combustibility and exposed surface are relatively identical.

In discussing the relative advantages of charcoal and coke in blast-furnace work for the production of pig iron, the author remarks that the relatively lower quantity of heat developed by the coke in the unit of time (which consequently necessitates the use of a larger quantity of fuel) is one of the chief causes for the poorer quality of the pig produced when coke has been used, than when charcoal has been employed. If it were possible to obtain the coke in as voluminous a condition as the charcoal, the results obtained would probably be similar.

On the Use of Water Cartridges.—In some experiments made at the collieries of the Bonifacius and Zollverein Associations, in the case of eight shots in which the dynamite was surrounded by water, part of the boreholes being in rock, and the remainder in coal, fire was observed on each occasion, this being occasionally accompanied by showers of sparks, thus proving that the use of water is not a sovereign specific under all circumstances for the prevention of explosions due to shot firing.

Utilization of the Vapours of Carbonization of Wood.—In the United States, increased attention is being given to the utilization of the vapours arising from the carbonization of wood in connection with the production of charcoal for iron works, and there is a great demand for acetic acid so obtained for the manufacture of white lead.

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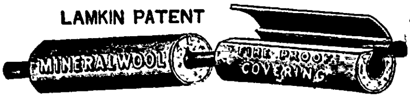

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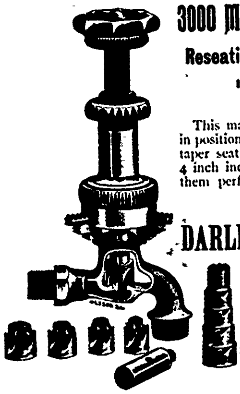

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