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Vol. XI.—No. 6. 1892—OTTAWA, JUNE—1892. Vol. XI.—No. 6.

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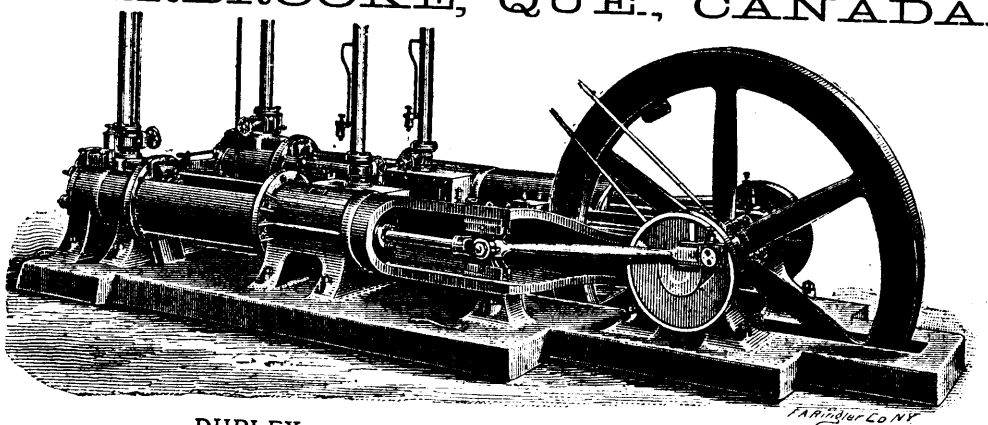

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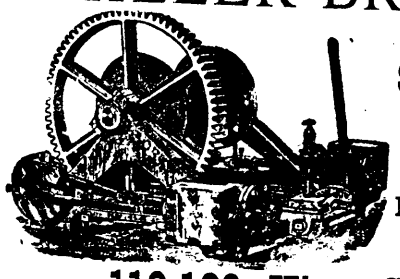

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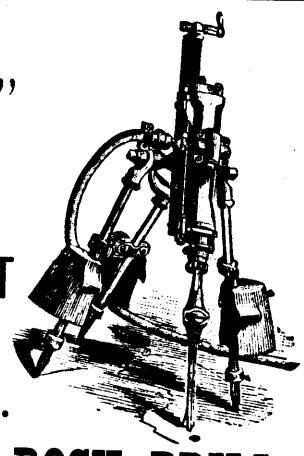

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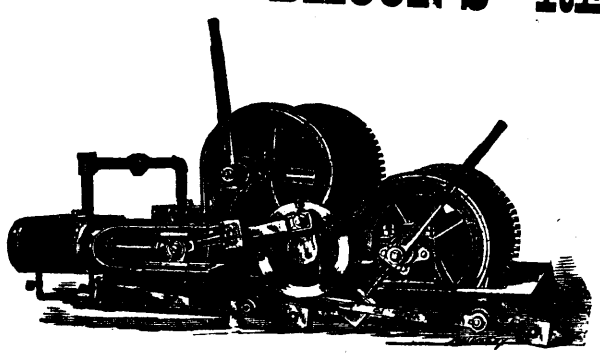

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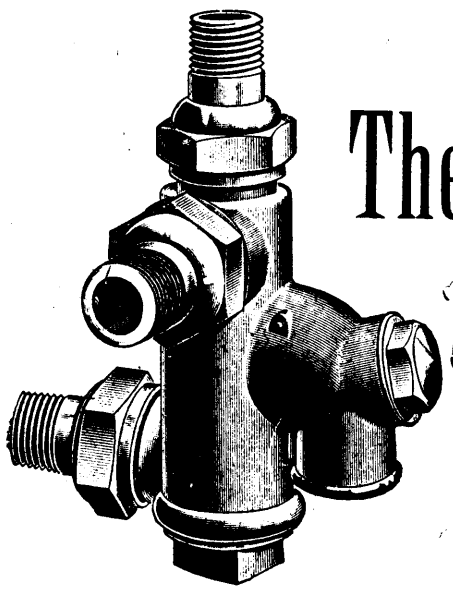

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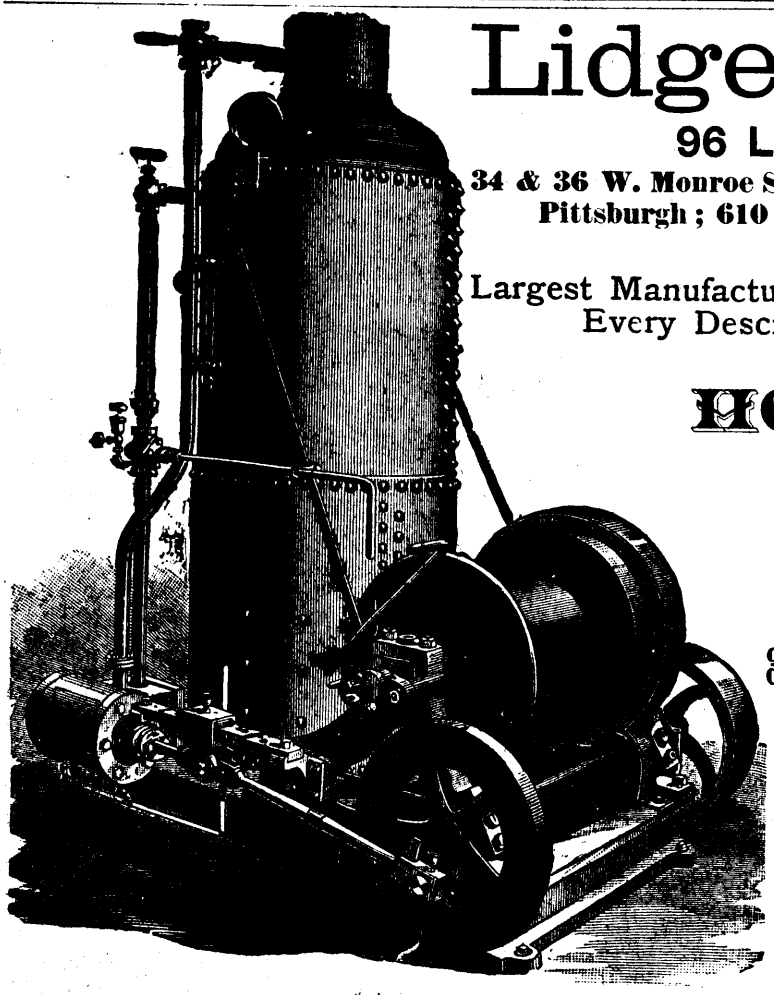

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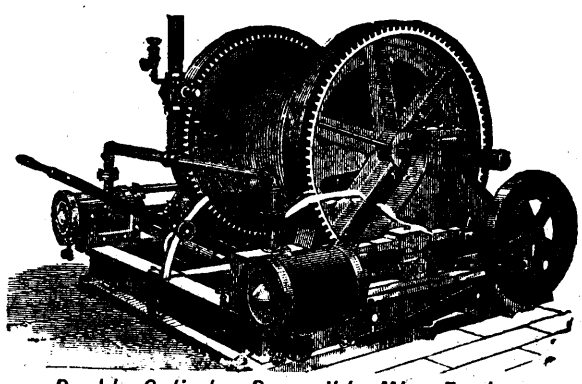

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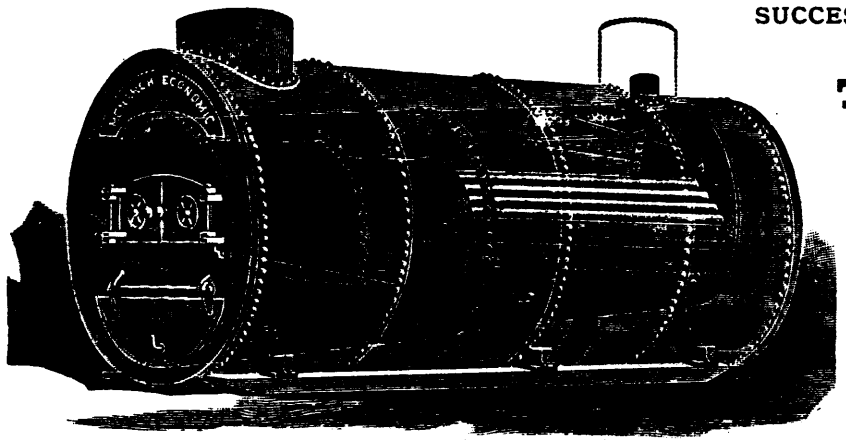

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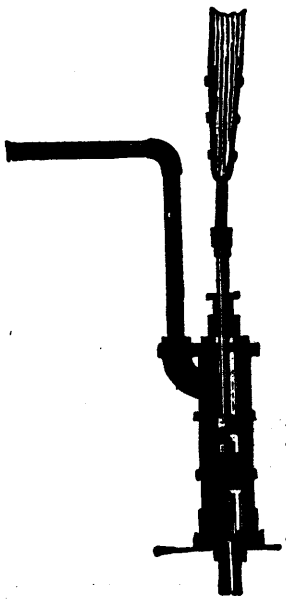

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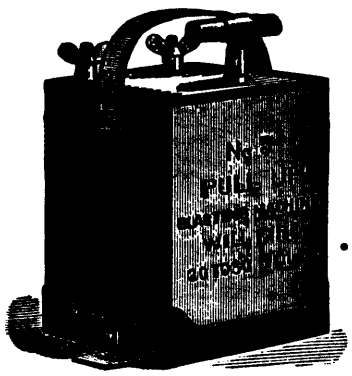

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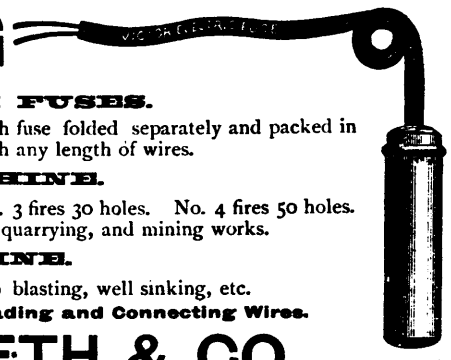

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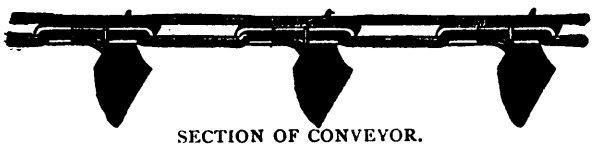

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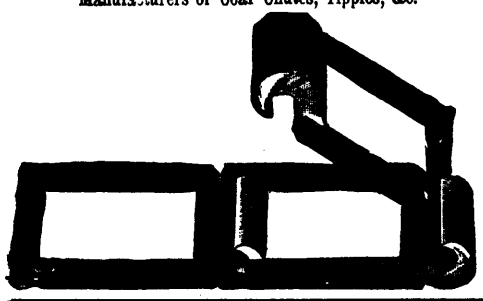

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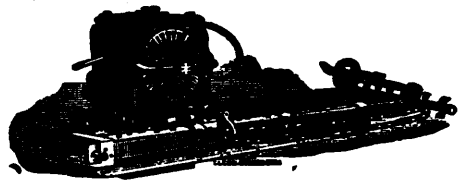

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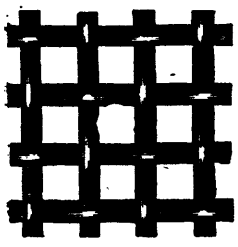

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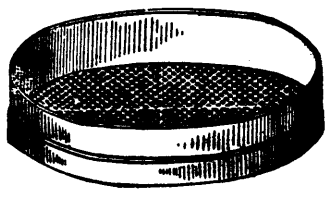

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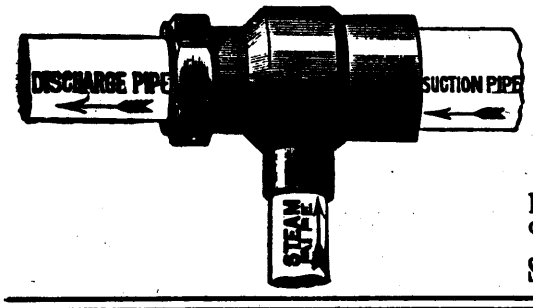

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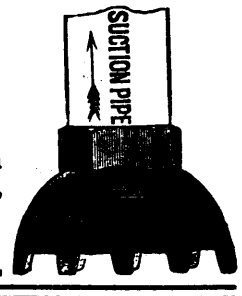

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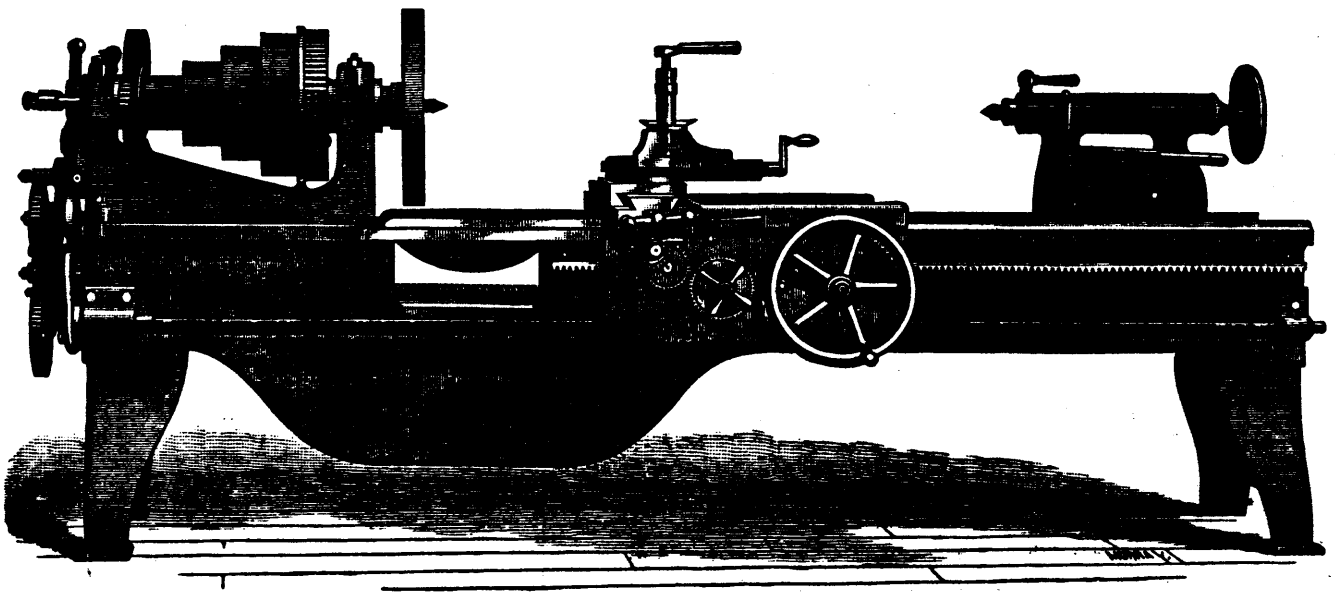

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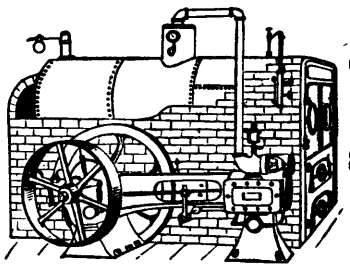

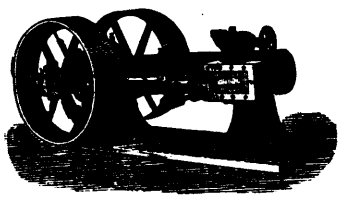

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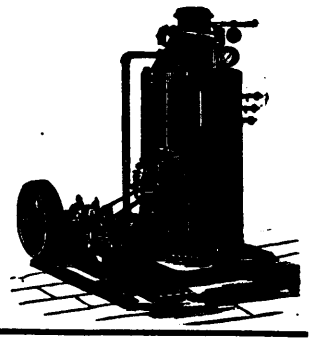

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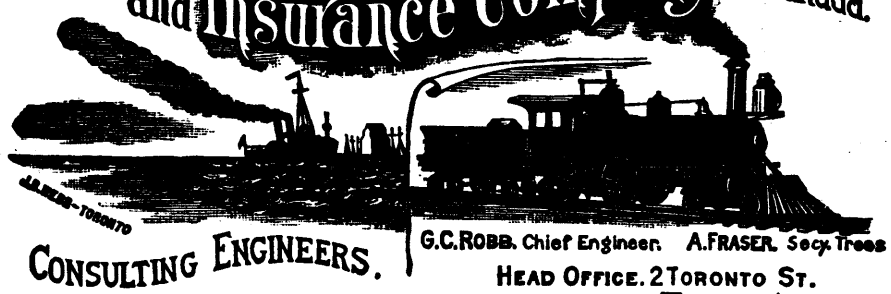

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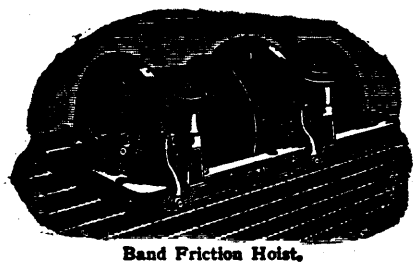

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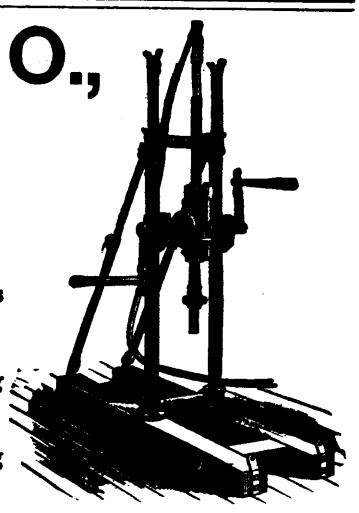

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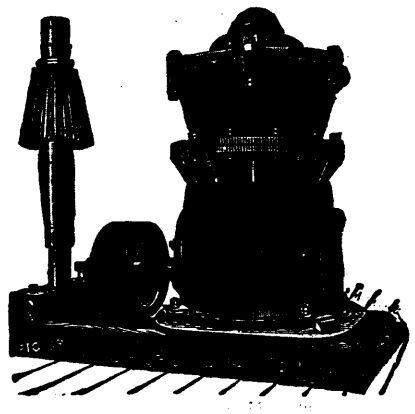

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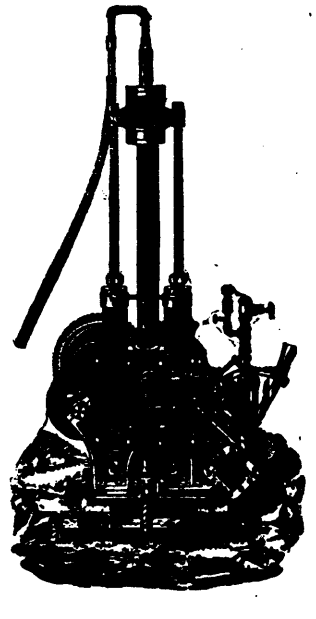

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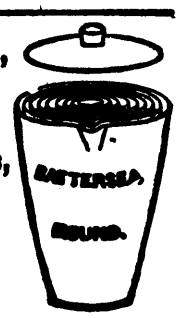

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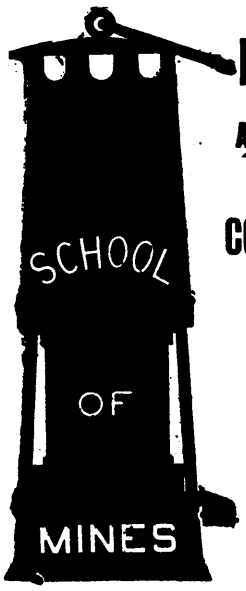

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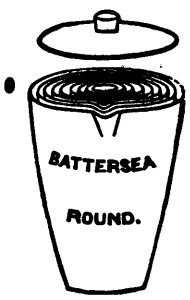

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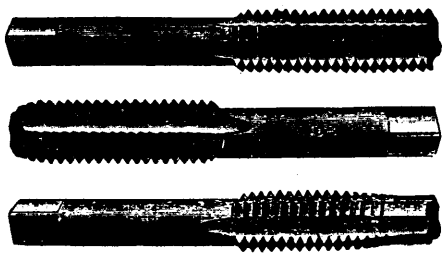

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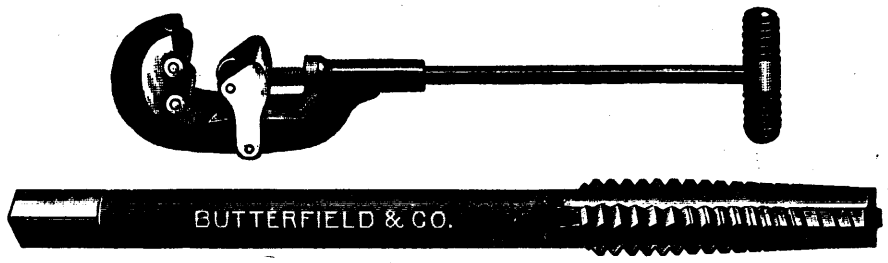

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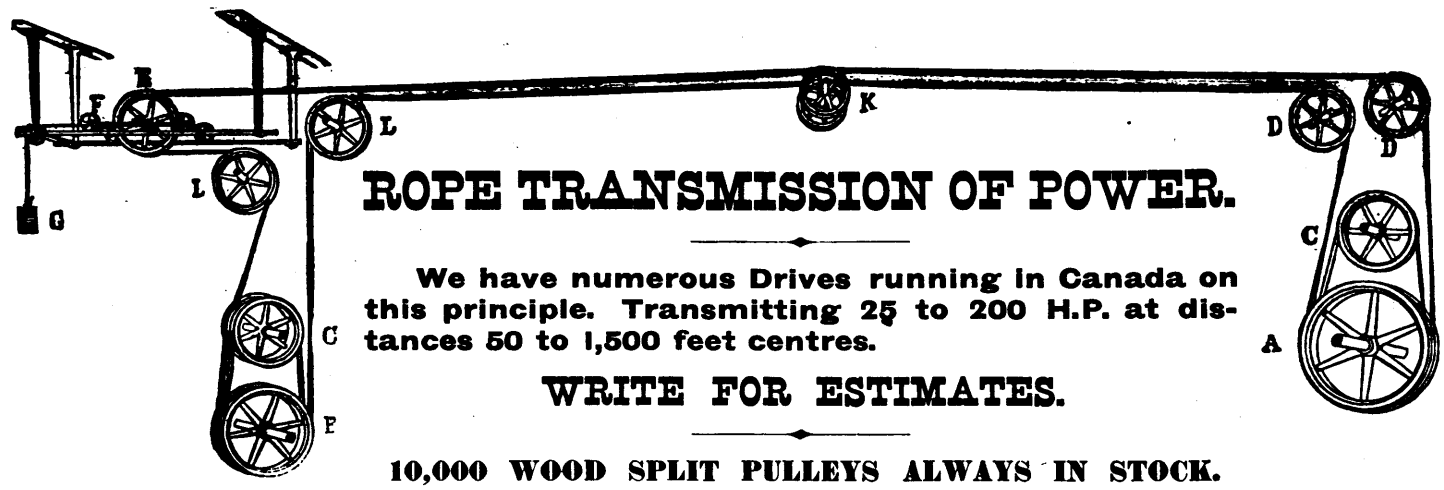

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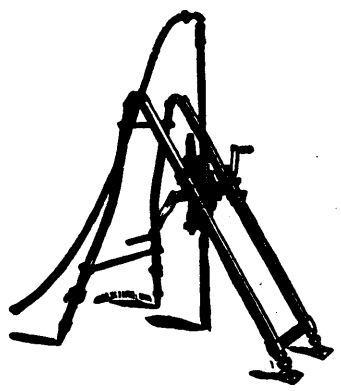

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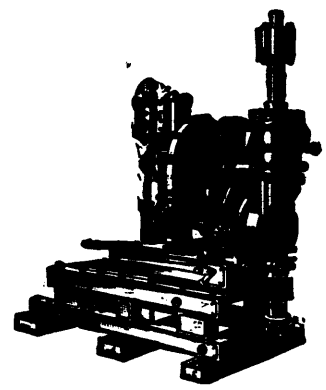

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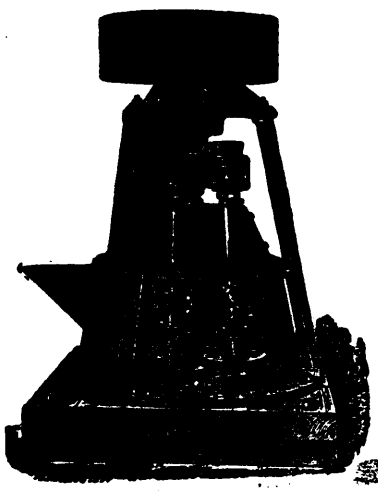

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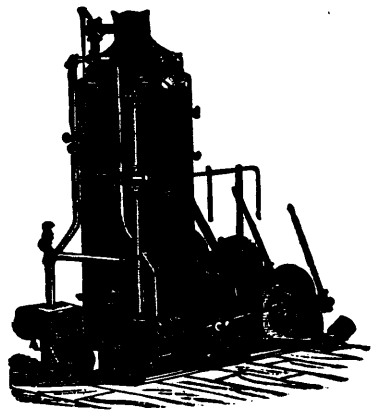

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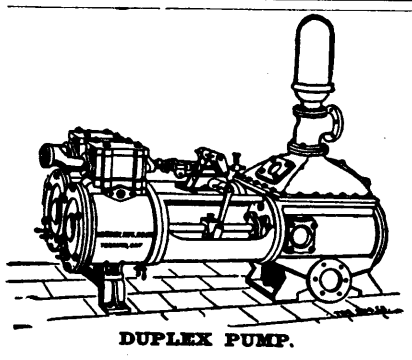

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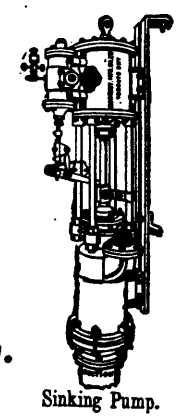

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THE CANADIAN MINING AND MECHANICAL REVIEW.

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

THE OFFICIAL ORGAN

—OF—

THE GOLD MINER'S ASSOCIATION OF NOVA SCOTIA,

THE UNITED MINING SOCIETY OF NOVA SCOTIA,

THE ASBESTOS CLUB, QUEBEC,

THE GENERAL MINING ASSOCIATION OF QUEBEC.

THE following Resolutions of Council indicate beyond a peradventure the status of THE REVIEW as the exponent of the Canadian Mineral Industries:—

The Gold Miners' Association of Nova Scotia.

"At the annual meeting of the Gold Miners' Association of Nova Scotia, held at Halifax on 6th March, 1889, THE CANADIAN MINING REVIEW was adopted the official organ of this Association.

(Signed), B. C. WILSON, *President.*
G. J. PARTINGTON, *Secretary.*

The United Mining Society of Nova Scotia.

"Moved by Mr. R. G. Leckie, seconded by Mr. C. A. Dimock, That the thanks of the Society be tendered to Mr B T A Bell for his kind offer placing the columns of THE REVIEW at the disposal of the Society, and that THE CANADIAN MINING REVIEW is hereby appointed the official organ of the Society."

(Signed), H. S POOLE, *President.*
H. M. WILDE, *Secretary.*

The Asbestos Club, (Quebec.)

"Resolved: That THE CANADIAN MINING REVIEW is, by authority of the Members and Council, hereby appointed the official organ of the Asbestos Club."

(Signed), D. A. BROWN, *President.*
A. M. EVANS, *Secretary.*

The General Mining Association of the Province of Quebec.

At a meeting of Council held at Montreal on Friday, 6th May, 1892, it was moved by Captain Adams, seconded by Mr. R. T. Hopper, and resolved: That THE CANADIAN MINING REVIEW be the official organ of the Association.

(Signed), GEORGE INGLIS, *President.*
B. T. A. BELL, *Secretary.*"

OFFICES:

Victoria Chambers, 140 Wellington Street,

OTTAWA.

Vol. XI. JUNE, 1892. No. 6.

Mining Legislation in Nova Scotia.

Last year the Government amended the Mines Regulation Act in a very vigorous fashion, and have had the satisfaction of seeing the English Parliament since following its lead in several important changes in the English Act. During the present session of the Legislature the Mines Regulation Act was left untouched, and the Mines and Minerals Act was taken in hand. It was consolidated and amended in anticipation of the regular consolidation taking place in a year or two.

The amendments were principally for the purpose of making the Act clearer, or for facilitating the working of its provisions. The most important changes were as follows:—

Formerly the lines of gold leases and licenses were parallel to and at right angles to the general course of the strata. To prevent confusion in new ground these lines will run due north and south. Provision has also been made for adjusting disputes over surveyed lines.

Prospecting licenses were formerly for a period of six months and renewable for six months more; the cost of the first period being 50 cents, of the second 25 cents, per area. After much calculation it was considered that 50 cents an area for the twelve months was an equivalent for the old rate. The provisions of the Act relating to procedure in the Commissioner's Court, and to appeals from his decision, and the legal machinery generally was simplified.

In the case of minerals, other than of gold and silver, an important change has been made. Formerly a lease of one square mile was granted for mining any of the following minerals: coal, iron, copper, lead, tin ores, etc. At present the coal area or iron leases remain one square mile in extent. A lease for mining copper or lead cannot exceed one-half a square mile in extent; and one for tin or precious stones cannot exceed one-quarter of a square mile in extent. It may be mentioned here that the term of gold leases has been increased from twenty to forty years, so that the regularity of royalty and the duration of term in gold mining are well secured for a number of years to come.

The Act as amended had been in preparation for some time, and it is to be hoped that it will remain unchanged for a few years, especially as the coal and gold industries have endorsed it, excepting, of course in the matter of increased coal royalty.

EN PASSANT.

In view of the meetings of the General Mining Association of Quebec at Thetford and Black Lake on 14th, and the Mining Society of Nova Scotia at Halifax on 17th inst., the June number of the REVIEW has been issued somewhat earlier this month. Early in July we will publish verbatim reports of the proceedings at each of these meetings, in a double number.

From the sixteenth annual report of Inspectors of Explosives for Great Britain, we learn that during 1891 twelve varieties were added to the authorized list of explosives. Among the different explosives noticed in the report, two samples of gun-cotton may be mentioned. One had been in a river for sixteen years, the other underground for nearly twenty years. Neither had suffered in any way. During the year several new varieties of smokeless powder were introduced. The condition of all the samples examined (except one) was satisfactory. There was but one death caused from accident by fire or explosion in manufacture during the year, giving an average in ten years of seven. Altogether, in those processes alone to which the act applies—namely, manufacture, storage, and transport—there were sixty-two accidents, causing five deaths and injuring twenty-nine persons. These figures show a most satisfactory contrast with those given before the Act came into operation. In the use of explosives 105 accidents are reported, causing the death of thirty-nine persons, and injury to 101.

A subject of interest to Canadians was the discussion at a public meeting held in Dublin the other day to consider the development of the peat fuel resources of Ireland. It is estimated that there are 2,500,000 acres out of 20,000,000 acres under bog in that country. The peat in some districts was light and porous, this applies to the turf that lay near the surface. Where the turf was more than three or four feet deep it ultimately passed into a condition which nearly approached coal; the vegetable fibre was broken up and a highly carbonaceous and compact mass was the result. There was little difference between it and coal in specific gravity. Many years ago the town of Mullingar was lighted with gas made from peat. An experiment made with peat fuel in a locomotive on the Northern Counties Railway had shown that in strength it compared favorably with coal. Some authorities held that condensed peat made better gas than some kinds of coal, but it was thought that in this instance it could be used to better advantage when in conjunction with an inferior coal. The outcome of the meeting was a resolution: "That the utilization of the peat bogs of Ireland in all the various branches of industry *they furnish is a subject well worthy of the attention* of the capitalist, the land owner and the occupier." Canada has an immense area of these same peat bogs, and it is interesting to note that an endeavor is now being made to manufacture the product into a compressed fuel suitable for steam and other purposes. It has been successfully utilized in Bremen, North Germany. There is no reason, judging by results obtained from recent experiments in Montreal and Toronto, why it should not be profitably turned to account in this country. The question of the utilization of the peat beds of Canada is one which has been receiving considerable attention of late, and several patents for its manufacture into fuel for steam purposes have been acquired by Montreal and Toronto people.

Meetings for June:—

GENERAL MINING ASSOCIATION OF QUEBEC, at Thetford and Black Lake, Que., Tuesday, June 14th.

THE MINING SOCIETY OF NOVA SCOTIA, at Halifax, on Friday, June 17th.

Members of these Associations will do well to be present and make a point of taking part in the proceedings.

The programme of the Thetford meeting embraces an interesting excursion to the asbestos mines. The papers to be read include: *The Labor Question in its Relation to Canadian Mining*, by J. Burley Smith, M.E., Glen Almond, Que.; *The Present Status of the Canadian Asbestos Industry*, by L. A. Klein, M.E., Black Lake, Que.; *Recent Practice in Economical Air-Compressors*, by F. A. Halsey, M.E., Sherbrooke, Que. A cold lunch will be served at Thetford mines at half-past twelve, noon. After the meeting, which takes place in the Asbestos Club House, Black Lake, members and their friends will be entertained to a dinner given in their honor by the local mine owners. Train leaves Sherbrooke Tuesday morning at eight o'clock.

The Mining Society of Nova Scotia will hold forenoon and afternoon sessions on Friday, 17th inst. Papers will be submitted by H. S.

Poole, John E. Hardman, J. Geo. Rutherford, J. S. McLennan, E. Gilpin, jr., and others. A programme of entertainment is being arranged for the evening.

According to the memorandum newly drawn up by British Trade Association, the production of coal is far from being so lucrative an occupation as some of the British miners appear to think. The latest available statistics (which might well be supplemented by others of a more recent date) show that during the ten years from 1877 the gross amount of mining profits in England and Wales assessed to income tax fell from £12,719,000 to £6,481,000, or rather more than half. Now, assuming the capital embarked in the coal trade at the latter date to be a hundred millions sterling, nearly as much more would be required to capitalize the other mining industries of the country, including ironstone, limestone, lead, copper, tin, etc. This would give us a total capital of some two hundred millions, upon which the six and a-half millions above mentioned would represent a profit of only 3 per cent That this estimate is not too low is shown by various facts; among others, that in 1873 the evidence given by several witnesses before the Coal Committee went to show that the average profits of the coal trade over a period of years had not exceeded 2½ or 3 per cent.

The prolonged howl for an export duty on nickel and other minerals made by the *Canadian Manufacturer* is universally condemned by the mining interests of this country, and fully merits the following timely rebuke of the *Iron Trade Review*:—

> The capital of citizens of the United States has developed Canadian nickel and copper deposits, in large part built railroads which employed Canadian labor and required large outlays for materials. The mines have furnished employment to a large number of men; the transportation of their output has been of vast benefit to Canadian railroads. Yet in spite of the fact that her nickel industry has been initiated, developed and encouraged by capital from this side of the border, and the demand for the product created by the United States, with all the benefits to Canada that have flowed from this consummation—in the face of all these facts, there is a movement in Canada to put an export duty on nickel. Assuredly there is need for a wide publication in the land of the Canucks of an ancient fable about the fowl and the golden egg, with a moral about the people who didn't know prosperity when they saw it.

A French firm is experimenting with a new alloy for armour plates, projectiles, and guns, viz., a steel containing one per cent. of chromium, 2 per cent. of nickel, and not more than 0.4 per cent. of carbon. The steel is first melted in an open hearth, and in the ordinary way. When the silicon and manganese in the metal have attained their proper proportions, the nickel and chromium are added successively in the form of ferro-nickels and ferro-chromes, or in the shape of double ferro-chrome and nickel.

English papers record a notable instance of calm courage on the part of a miner named Sidlow when in the face of extreme danger. Sidlow and his companion were pit sinkers, and were engaged in blasting operations at a depth of 1,200 feet. Four charges were rammed, and a tape fuse, which would be long enough in burning to give them time to get away, was lighted The men got into the hoppet and gave the signal, but to their dismay the bell was silent and the hoppet did not move. Sidlow instantly jumped out and tried to extinguish the smouldering fuze, but it had burnt too far into the hole for him to stop ignition. Sidlow did his utmost to reassure his companion, and both got into the hoppet again and crouched down. Immediately came the "shot," bringing down shattered fragments of stone and earth, which nearly buried the cage and enveloped the unfortunate miners in suffocating smoke. Poor Mullaney appears to have lost his senses from fear and excitement. He violently kicked his companion, and then lay still. He was dead! At length the hoppet began to ascend, and brave Sidlow, insensible, and almost suffocated, was taken to the surface. It was then found that the bell rope had accidentally broken, and the banksman was afraid to wind without the usual signal, fearing he might either injure the men or leave them behind. There seems no reason to doubt that the occurrence was purely accidental. Edward Sidlow owes his life to his own calm courage, and is entitled to great praise for the efforts he made, unhappily without success, to impart courage to his companion.

Apropos of Dobson, a Toronto gentleman well versed in his career in that city, sends us the following: "Mr. James Hedley, editor of *The Monetary Times*, Toronto, has just returned from Chicago, where he tells me he met a much aggrieved individual named C. M. Dobson, who was complaining bitterly of the way he had been treated by the REVIEW, threatening libel suits and blustering considerably. Hedley knew nothing of Dobson's antecedents or his career when here, and he asked if I could tell him anything about him. Hedley says that Dobson admitted having used the A.R.S.M. when he had no right to, but pleads that he did so when young and foolish. Col. ——— says, however, that he is using these letters yet. You will notice that in his letter to the Ottawa *Free Press* Dobson does not say that he was or is an Associate, but merely that he attended the Royal School of Mines, Jermyn Street, London, for three years. I suppose that Mr. T—— told you about the fraudulent affidavit regarding a certain lot in Ontario in which Dobson swears he visited it on a certain day, when, as a matter of fact, he had never left Toronto. His affidavit is filed in the Crown Lands Office here and can be seen any time. I think you ought to get all particulars and publish the facts." With all due deference to the suggestion of our esteemed correspondent we must, for reasons already stated, decline to give any details of Dobson's career. Our object in warning our readers against a first-class fraud has been accomplished.

The Krupp works at Essen keep no less than 20,000 men constantly employed, burn daily 1,700 tons of coal and coke, and consume 26,000 cubic metres (918,231 cubic feet) of gas. The various departments and shops are connected by 44 kilometres (27 miles) of normal way, served by 14 locomotives and 542 waggons, besides 29 kilometres (18 miles) of small-gauge way, with 14 locomotives and 450 waggons. There are 140 telephone lines, and 80 kilometres (50 miles) of telegraph lines. The works also contain 2,542 furnaces of all kinds, 21 roll trains, 82 steam hammers, 450 steam engines of 2 to 1,000 horse-power, 439 boilers, and 1,622 machine tools and other mechanical appliances.

Among the applications of electricity to machinery that of its union with travelling cranes is of no mean importance. Instead of having a certain predetermined speed of travel and hoist, that cannot be departed from, the electric crane possesses the advantage of being under perfect control of the operator, can be gradually accelerated or retarded, smoothly and noiselessly, or may be kept at the same speed indefinitely. Three 15 ton cranes are in operation in a Milwaukee shop, having a hoisting speed of 25 feet per minute, a longitudinal traverse speed of 350 feet and a transverse traverse speed of 125 per minute.

An improved coal-mining machine has been patented by Mr. J. Taylor, Illinois, U. S. A., which is designed to be operated by an electric motor placed on the machine. The machine is advanced by hand or by any available power as the cutting proceeds until the body of coal to be detached is undermined. A stationary frame is secured to fixed support, and two arms extending forward are pivotted to the frame, the cutting wheel being journalled between the ends of the arms. The cutters in the rim of the wheel are removable, their shanks extending through the rim and receiving nuts. There is a toothed rim on the upper face of the cutting wheel, engaged by a bevelled pinion on a shaft journalled in bearings on the upper pivotted arm, this shaft also having a spur wheel for receiving power from an electric motor. Owing to the construction of the arms carrying the cutting wheel, the wheel is adapted to cut a grove in the body of the coal equal in depth to nearly its own diameter.

One of the 4in. nickel steel armour plates for the cruiser *New York* was tested the other day. Three shots were fired from 4in. guns, with an initial velocity of 1,420 feet per second. Carpenter projectiles were used, and all rebounded without piercing the plates.

The *Electrical Review* notices a method of examining the atmosphere in mines which is now being used at Kolcheid, near Aachen. Briefly, it is as follows:—A gasometer is placed in the chief ventilating shaft and is so arranged that it becomes filled in twelve hours; in this way it is possible to obtain a fair average sample of the mine air. The air thus collected is now examined by means of a Coquillon's "grisometer." Any free carbonic acid gas that may be present is absorbed by caustic soda, and its percentage estimated by noting the diminution in bulk. The marsh gas is now decomposed by a platinum wire heated to incandescence by means of an electric current. A further diminution in bulk takes place, and this being observed, the percentage of marsh gas present in the pit air can be calculated.

Our Portrait Gallery.

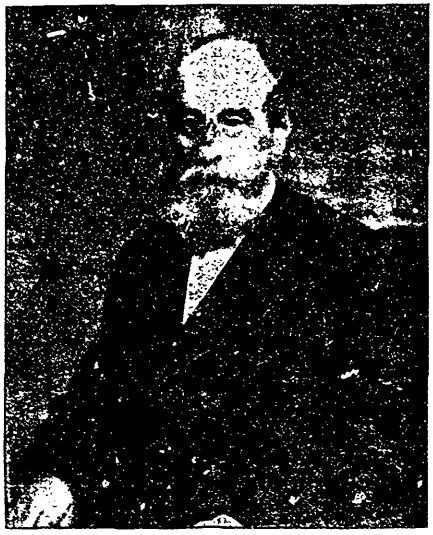
[A series of portraits and biographical sketches of Canadian mining engineers, mine managers, inspectors, geologists, explorers, etc.]

No. 17.

Sir John William Dawson, C.M.G., LL.D., F.R.S., F.G.S., etc., etc., Principal of McGill University, Montreal.

Amongst the foremost scientific men of this age, not only in America, but also in Europe, we find the subject of this sketch.

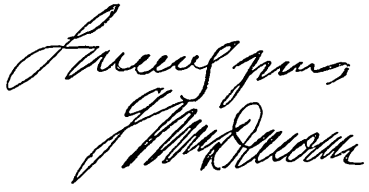
But few men have lived to enjoy so fully the results of a life full of activity and unceasing devotion to the advancement, progress and research in almost every department of life. To-day, Sir William is as actively engaged in matters scientific, educational, and religious, as he was in the prime of his manhood, and time seems not to have made even the slightest impression upon his zeal or earnestness, upon his love for work. Endowed with a splendid physique and a superabundance of intellectual power, Sir William Dawson strives in the world to-day, and is known, beloved, and respected by millions on both sides of the Atlantic.



Born in the town of Pictou, Nova Scotia, *in 1820, young Dawson received his early* training and education there. One of his favourite hobbies was the collecting of natural history specimens peculiar to his province. At the age of twenty he went to the Edinburgh University, Scotland, to make more extended studies. In 1842 we find him assisting Sir Charles Lyell, then one of the ablest of living geologists, in his examination of the geological resources of Nova Scotia. Subsequent to this, the subject of this notice returned to Edinburgh and made further studies, especially in the science of chemistry, and kindred branches. His first paper on "Field Mice" was read before the "Wernerian Society" of Edinburgh, in 1841. Then followed several papers on various branches of science, but he was soon back to his birth place, where he was appointed by Sir Edmund Head a commissioner to regulate the affairs of King's College. Educational matters now occupied most of his time. But his favourite study, geology, soon made its way out, and he lost no opportunity of carrying on investigations into the coal, iron and gypsum deposits of Nova Scotia. Fossil plants attracted his attention from earliest times, and now he is foremost as a palæobotanist, in which subject Sir William decidedly excels. The *Edinburgh Philosophical Journal*, the *Royal Society* publications, and the other leading magazines and periodicals were now open for articles from his facile pen. Papers bearing upon the economic resources of Nova Scotia show the interest and active part which he took in the development of natural resources in those early days. With never-flagging zeal he pursued his geological studies, which led to important discoveries.

He was then called upon to deliver lectures on geology and natural history in Pictou Academy, Dalhousie College, and was entrusted with a "Report on the Coal Fields of Southern Cape Breton" for the Nova Scotia Government.

In 1854 he was elected Fellow of the Geological Society of London, to whose quarterly journals he has ever since contributed numerous useful and interesting papers. He discovered and described the oldest known reptiles at the time, and the remains of the earliest land snails known. In 1855 Mr. Dawson published his well-known work, "Acadian Geology," on the geological structure, organic remains, and mineral resources of Nova Scotia, New Brunswick, and Prince Edward Island. This admirable and indispensable work to the student of geology has since gone through several editions, and is now more than double its original size. In his researches on the vegetation of the Devonian period, prior to the Carboniferous, or Coal measures, Dawson's name stands foremost. It was to his friend and colleague, Sir Charles Lyell, that his "Acadian Geology" was dedicated.



In the same year (1855) Mr. Dawson was called upon by the authorities of McGill College to take the principalship of that institution. A comparison of the condition of the college in 1855 with what it is now is sufficient warrant to any one of the long-sightedness and wise policy of the Board of Governors, as well as a distinct mark and standing monument to his industry, zeal, and practical ideas on educational matters. Besides his more scientific works on geology, and hundreds of papers on divers facts and observations, Dr. Dawson (as he has been wont to be called for many a year) published a number of popular works, amongst which we may mention the following: "The Origin of the World," "The Story of the Earth and Man," "The Dawn of Life," "Fossil Men and their Modern Representatives," "The Chain of Life in Geological Time," etc., etc.

In his researches on *Eozoon Canadense*, conjointly with Sir William Logan, Dr. W. B. Carpenter, Dr. T. Sterry Hunt, and many others, Dr. Dawson has created for himself a reputation and a name which stands high. Amongst the text books which he wrote we find his "Acadian Geology," "Manual of Zoology," especially adapted to Canadian students; "Lecture Notes on Geology," a most useful and comprehensive digest or *resume* of geology. We have, besides, numerous other works, amongst which are his Reports on the Devonian and Carboniferous Plants of Canada, prepared and published by the Geological Survey of Canada, by Act of Parliament.

In 1862 Dr. Dawson was elected Fellow of the Royal Society of England, the highest honour which a British scientist can obtain from his *confreres* and admirers. In 1882 he was elected as President to the Royal Society of Canada, founded by the Marquis of Lorne. He has been President of both the American and British Associations for the Advancement of Science more than once. He is a Master of Arts of Edinburgh University, an LL.D. of McGill, whilst in 1884 Her Majesty the Queen was pleased to bestow upon him the Order of Knight Bachelor, in recognition of his valuable services to science, and his Alma Mater in the same year created him an LL.D. of that University.

As a geologist, and an educationalist, Sir William Dawson to-day stands high. His flowing words and store of knowledge make him interesting and attractive at all times. In the domain of archæology and archæological remains, Sir William has made extensive researches here in Canada, described many of the implements and remains of the earliest dwellers on this continent, connecting therewith almost invariably the related topic so brimful of interest as to the "Antiquity of Man."

Like MM. deQuatrefages and E. de Laveleye, just recently deceased, and Dr. Dana, Sir William Dawson is not only hard-working and painstaking in his researches in science, but also a Christian in the highest practical sense of that term.

Throughout the whole length of his life one *can see the continuous thread of an existence* which has a higher motive power at its back. In the world of higher Biblical criticism, of reconciling "Science and Religion," Sir William Dawson has done much to clear up numerous and important, as well as intricate questions, which required careful comparisons and accurate observations. "Facts and Fancies of Modern Science," "Modern Ideas of Evolution," and similar works of captivating interest and philosophic turn of mind are amongst his best known works, whilst his works and papers on Egypt

and Syria are not less profitable. It shows us clearly, then, that the sphere of scientific research is by no means incompatible with that of higher culture and Christian ethics.

The Director of the U. S. Mint has estimated the total output of silver throughout the world in 1891 as 140,865,000 ounces, showing an increase of 8,032,000 ounces compared with 1890, or an increase of about 5½ per cent. The value of the output last year, however, is returned as 300,000 dollars less than in 1890, owing to the fall in price. The price averages for the last three years were as follows; - 1889, 93·5 cents; 1890 (the year in which the Silver Act was passed), 1·05 dollars, 1891, 98 8 cents, It is predicted that the output will fall off considerably this year. As regards the increased output of last year, it must be pointed out that it was considerably more than covered by the increased purchases on account of the Treasury to the extent of about 14,000,000 ounces, as against 1890, that is, deducting from the total Treasury purchases of last year the similar purchases under the Silver Act and its predecessor, the Bland Act, in 1890.

From returns furnished by our New York correspondent, the shipments of Florida phosphates, 75/80%, from 1st January, 1892, to 21st May, have been as follows:—

To Barbadoes	782	tons
" Liverpool	3,442	"
" London	7,520	"
" Hamburg	6,200	"
" Stettin	8,004	"
" Rotterdam	2,486	"
" Copenhagen	1,900	"
" Denzig	1,540	"
" Genoa	2,338	"
" Munich	1,875	"
" Ipswich	1,475	"
" Baltimore (U.S.)	812	"
" Valencia	505	"
" Wilmington (U.S.)	840	"
" Kastrup	1,645	"
" Boness	3,250	"
Total	44,614	"

A correspondent informs the *Engineering News* of a remarkable accident that occurred recently to what is probably the longest single span cable-way in the world, being that at the Deer Park group of mines, near Descanso, California, used for conveying ore from the mines high up a mountain side to the mills below. It has a single span of 4,450 ft. and has a tension of about 20 tons. The loads were 120 lb. sacks of ore. It was a working success for two days. It parted just after an extra hard "shake" in the series of earthquakes to which that part of California has been subjected. It is supposed that the vibrations coming from the end of the line and meeting in the middle were the cause of the break. It will be replaced by a heavier one.

Big Gas Meters.—The meter department of the Pittsburgh Supply Company is making two of the largest meters ever made. They are for use on natural gas lines, where the pressure runs up to 60 pounds to the square inch. When worked at ordinary mill pressures of from 5 to 6 ounces they have a capacity of 100,000 cubic feet per hour, but can be worked up to 120,000, and when working at 60 pounds pressure they register from 500,000 to 600,000 feet per hour, or from 12,000,000 to 15,000,000 cubic feet per day, more than a great many wells can furnish These meters will be used on lines at Buffalo, N.Y. In addition to the above the company is working on orders for eight meters with a capacity of 10,000 feet per hour, and two with a capacity of 50,000. This company carries a large stock of meters on hand, with capacities ranging from 10,000 to 100,000 feet per hour. It is at present designing a new meter, which will be put on the market in the near future, and is intended for fuel gas for house purposes and illuminating gas for general purposes.

Explosions in Coal Mines.*

By J. B. Atkinson.

No industry has been subject to disasters involving so large a loss of life as coal mining, and these disasters have been principally due to explosions.

The magnitude of colliery explosions has strongly directed public attention to the dangers of mining, and has led to the passing of Mines' Regulation Acts, each more stringent in its provisions than its predecessor. It is now held by many persons that the extension of nearly all the larger explosions has been caused by coal dust, and even that some explosions have been wholly due to the combustion of that agent.

The words "coal dust" do not occur in any Mines' Regulation Act except that of 1887. It is evident, therefore, that an important factor in colliery explosions has been overlooked, and it is probable that many explosions have occurred simply from a want of knowledge in which all connected with mining have shared.

The influence of fire-damp in explosions has been twofold, it is itself the cause of explosions, and it has diverted attention from another factor—coal dust.

We may even go further, and say that one of the precautions, large currents of air, adopted to lessen the danger of fire-damp, has directly assisted in increasing the danger of coal dust by rendering the mines dryer, and promoting the formation of the most dangerous class of dust deposits, those due to the fine upper or wind-borne dust and common on many main intake and haulage roads.

If these considerations be true it is clear that our knowledge of the causes of colliery explosions, and of means for their prevention, will require to be recast, and in this paper attention will be especially directed to coal dust as the cause of explosions that is least understood. Explosion may be defined as the sudden large increase in volume of matter.

In practice accidental explosions are of the following kinds:—

(*a*) The expansion of gunpowder and allied explosives on combustion.
(*b*) " " dynamite and allied explosives on disassociation.
(*c*) " " mixtures of inflammable gases or vapours with air on combustion.
(*d*) " " mixtures of inflammable dust with air on combustion.
(*e*) " " gases or vapours under pressure on the rupture of retaining walls.

a, *b*, *c*, and *d* may be called chemical explosions, and are accompanied by flame; *e* may be called a mechanical explosion, and is not accompanied by flame.

Explosions under the above heads occur in mines. This paper will, however, be confined to the consideration of the explosion of mixtures of fire-damp and air, and of mixtures of coal dust and air, and also of gunpowder and other explosives, so far as they initiate the two former classes of explosions.

A true explosive is a body containing within itself the power of explosion. Thus gunpowder on the application of heat, or nitro-glycerine compounds on detonation or shock, explode without the assistance of any other body. These are true explosives. Fire-damp and coal dust are not explosives. Mixtures of fire-damp and air or of coal dust and air are explosive, but the oxygen of the air is as essential to the explosion as the fire-damp or coal dust. It is scientifically incorrect to speak of the explosion of fire-damp or coal dust. Gunpowder is an example of a solid explosive, nitro-glycerine of a liquid explosive, and there are explosive gases, but they are never met with out of the laboratory. Thus one of the oxides of chlorine (hypochlorous acid) is an explosive gas. When slightly heated it decomposes with explosion.

Fire-damp is usually a mixture of marsh gas, with nitrogen, oxygen, and carbonic acid gases. The marsh gas or light carburetted hydrogen is the combustible constituent. Fire-damp is pent up in the strata at high pressures, and issues into the workings of a mine, usually as a steady flow, but sometimes as a sudden outburst In elevated unventilated parts of mines it collects, and often issues from such places in large volume on a fall of the barometer.

When flame is applied to fire-damp issuing as a jet into the atmosphere, it burns at the point of issue like ordinary lighting gas. There is combustion but no explosion. If mixed with air in certain proportion, flame passes rapidly through the mixture, and explosion results, the explosion being wholly due to the expansion of the resultant gases, caused by the heat of combustion. There is no absolute increase in volume of the mass, such as takes place when gunpowder is fired, when the resultant products, apart from the expansion due to the heat of combustion, occupy many times the volume of the original gunpowder.

The temperature of ignition of an inflammable mixture of fire-damp and air, the speed of the passage of flame, the temperature of combustion, the increase in volume of the resultant gases if free to expand, the increase of pressure if confined, and the composition of the resultant gases, are all points for consideration to which it is not proposed to direct attention. Recent researches, however, have shown that, as regards the speed of flame, the pressure developed, and the composition of the resultant gases of an explosion of fire-damp and air, the older text books are not altogether correct.

Coal dust is more or less prevalent in all dry coal mines. When the heat of a mine raises the temperature of the air entering the mine its capacity for absorbing moisture, or its drying power, is increased; and if the quantity of moisture in the strata mined, and that due to the respiration of men and horses, and to the combustion of lights, is not sufficient to saturate the air, the mine becomes dry. The temperature of the strata increases with the depth, while the quantity of moisture usually decreases. Deep mines are, therefore, dryer than shallow mines.

Some coal seams produce more dust than others—the more friable the coal the more dust. Coal seams are traversed by joints or cleavage planes running at right angles to the plane of stratification, and by partings parallel to the stratification. The latter planes of division are very generally coated with a dull, black, friable substance, known as mother of coal, dant, or mineral charcoal, which probably is largely present in fine coal dust.

The hewing, filling, and leading of the coal are the principal causes of coal dust deposits in mines. Two other causes are (1) the falling of coal from the sides of the passages, and its subsequent trituration by the feet of men and horses, and (2) the carrying down of coal dust from the screens on the surface by the air current descending the downcast shaft.

If a pound of ordinary coal is placed upon a fire it burns and is eventually consumed; first the combustible gases that are driven off combine with the oxygen of the air, producing flame and heat; next the solid carbon is consumed until nothing but ash remains. It can be shown by calculation that if the combustion of the pound of coal took place suddenly the heat given off would so expand the resultant gases that explosion would result, exactly as in the case of the combustion of fire-damp. If the pound of coal was in the form of fine dust and suspended in air, under some conditions such rapid combustion will take place, and this is a coal-dust explosion.

The explosions of fire-damp and air and of coal dust and air are therefore in some respects similar phenomena; in each case the explosion depends on the heat of combustion expanding the resultant gases, and each explosion is accompanied by flame. In vitiation of the atmosphere. A mixture of fire-damp and air readily takes place—the motion of the air in a mine, the mobility of the fire-damp, and the property of diffusion which gases possess, even when stationary, all favour the mixture. The fire-damp is readily ignited, and does not require to be broken up before combustion takes place.

With coal dust and air the conditions are different, and opposed both to the ready formation of an explosive mixture and its subsequent ignition.

Coal dust is a solid body; it is not present in the air of a mine under ordinary conditions in any considerable quantity, but requires to be raised from the floor or dislodged from the sides and roof before a cloud is formed; it requires to be broken up, or the gases it contains driven off, before combustion takes place. The combined effect of these conditions makes it difficult to initiate an explosion of coal dust and air. The fact that it requires special conditions to obtain an inflammation of a cloud of coal dust in an air free from fire-damp does not, however, prove that the extention of an explosion in such a mixture is equally difficult to obtain, because the conditions are then different. After an explosion is started in a mine the coal dust is no longer quiescent, but is blown into the air by the explosion, and forms a dense cloud; behind this cloud is heat, flame, and pressure. The behaviour of coal on an ordinary fire resembles somewhat that of coal dust in an explosion. The first step to start a coal fire is to ignite paper. The paper ignites wood, which in turn ignites the coal; once a coal fire is throughly kindled it is self supporting, but the coal cannot in the first instance be readily ignited without the assistance of heat from other material.

The heat and consequent force developed by the inflammation of a mixture of fire-damp and air in such proportion as to secure complete combustion is greater then the heat and force developed by a similar mixture of coal dust and air.

Mixtures of fire-damp and air are, however, only capable of transmitting flame within certain limits. There must be from 5 to 20% by volume of fire-damp in the mixture. The ease, with respect to coal dust and air, does not appear to be parallel. One pound of coal dust and 160 cubic feet of air are required for complete combustion. Assuming an air-way to be 8ft. by 5ft. sectional area, and taking coal dust to weigh 26 lbs. per cubic foot, then for each 160 cubic feet of air in such a road to be supplied with 1lb. of coal dust, the surfaces of the road would require to be coated with a film of dust $\frac{1}{32}$nd inch thick. Such a quantity is far below what in practice is present on ordinary dusty roads, along many of which it has been observed that an explosion has passed with great force. These roads would, at the time of the explosion, have suspended in the air a quantity of dust in excess of 1lb. to 160 cubic feet of air, and in no case where the dust was pure has the writer seen any evidence that the passage of an explosion has been checked by an excess of dust. It seems that in a coal dust explosion a minimum quantity of dust must be present, which is probably much greater than the quantity named as being required for perfect combustion, but practically no maximum. If this be true, it has an important bearing on the question. The minimum quantity of coal dust occurs constantly over long lengths of roads in mines, and consequently the conditions are present for the propagation of a coal dust explosion. That is to say, many roads in mines, in their normal condition, contain the necessary agents for an explosion of coal dust and air; while a similar state of

*Transactions Mining Institute of Scotland.

things, due to the presence of fire-damp and air, is an abnormal condition.

With regard to the force developed by an explosion of coal dust and air, as compared with the force developed by the explosion of fire damp and air, the following is worth consideration :—

In an explosion confined to coal dust and air, traversing a road in a mine containing a large excess of fine coal dust, there will probably be only coal gas distilled from the dust consumed; the combustion of coal gas results in more heat than the combustion of an equal volume of fire-damp, the coal gas containing free hydrogen; if this excess of heat is equal to the heat absorbed in distilling the coal gas from the dust, then the heat available to expand the resultant gases will be as great in the one case as in the other. Experience in actual explosions shows that, where there is a large excess of fine coal dust, the force developed is greatest.

In an explosion of fire-damp and air or coal dust and air, a limiting factor is the quantity of air the road contains; fire-damp, if present in volume so as to form the most explosive mixture, occupies one-tenth of the air space; coal dust may be present in excess, and yet practically leave the road full of air.

Sir F. A. Abel, when experimenting on coal dusts, observed that one of the samples of dust, consisting largely of stone dust, had the property of determining the ignition of a mixture of fire-damp and air not inflammable *per se*. This led him to experiment under similar conditions with non-inflammable dust, such as calcined magnesia, and he obtained similar results—that is to say, a mixture of fire-damp and air not inflammable *per se*, became so on the addition of a non-inflammable dust. This shows that coal dust may act in two ways in explosions:—1st, it may supply combustible matter; and 2nd, it may cause mixtures of fire-damp and air not inflammable *per se*, to become capable of transmitting flame.

Having satisfied ourselves that fire-damp and coal dust are the only bodies that, in conjunction with air, cause explosions in mines, we can investigate the subject (1) by the study of actual explosions, and (2) by experiment.

Explosions may be studied by observation made in the mine after their occurrence, or by the perusal of published accounts.

The writer has visited the scene of a large number of explosions in mines, most of which were caused by the ignition of small quantities of fire-damp, and were not generally followed by any death, or caused much damage to the mine. Some of these ignitions resulted in one or two deaths—the persons injured usually living for a few days after the accident. In a few cases of undoubted fire-damp explosions, lives were lost in the mine, but this was exceptional.

The most considerable explosion of fire-damp which the writer has personally investigated occurred at Whitehaven Colliery on the 25th April, 1885.*

In a few cases of minor explosions, investigated by the writer, coal dust had some influence, more as extending the flame of a gunpowder shot.

The writer has had opportunity of becoming acquainted with the circumstances attending the large explosions described in Table I., soon after their occurrence, and he at the same time made more or less complete examinations of the mines; *he believes that in these explosions coal* dust played a leading part.

The explosions in the table are, it must be noted, not selected, but comprise all the large explosions the writer has personally investigated.

TABLE 1.

No.	Colliery.	Date.	Lives lost.	Flame causing explosion.	Agent first inflamed.	Agent causing extension of explosion.	Point of origin of explosion.
1	Seaham.....	25th October, 1871..	26	Gunpowder shot	Coal dust....	Coal dust.....	Intake air way
2	do	8th September, 1880	164	do	do	do	do
3	Trimdon Grange..	16th February, 1882	74	Open light.....	Fire-damp...	do	Engine landing next drowned workings
4	Tudhoe.....	18th April, 1882....	37	Gunpowder shot	Coal dust....	do	Intake air way
5	West Stanley	19th April, 1882.....	13	do	Coal dust & ⅛ of fire-damp	do	Working face
6	Usworth.....	2nd March, 1885. .	42	do	Coal dust....	do	Intake air way
7	Altof.	2nd October, 1886..	22	do	do	do	do
8	Elemore.....	2nd December, 1886	28	do	do	do	do
9	Walker.....	24th October, 1887..	8	do	Coal dust & ⅛ of fire-damp	do	Working face
10	St. Helens.....	19th April, 1888....	30	Fire in the mine.	Fire-damp...	Fire-damp, coal gas & coal dust.	do

The reasons that lead to the conclusion that coal dust was the principal factor in these explosions will be stated shortly.

First, there are reasons of a negative character depending on the apparent impossibility of ascribing the explosions to the combustion of fire damp, the only body other than coal dust likely to cause them.

In Nos. 1, 2, 4 and 7, the explosions were entirely confined to the intake air ways; in Nos. 3, 6 and 8, the principal effects of the explosions were observed on the intake air ways, although some of the working faces were traversed, and the return air ways were affected to a very limited extent. In No 5 the intake air ways, the working faces, and the return air ways were all traversed. In No. 9, a small explosion, the working face and return air way of one district were affected. In No. 10 the working face of one district and intake air way were traversed, but owing to operations that were being carried out to isolate a fire at the working face, the direction of the air current had been changed shortly before the explosion, and a part of the intake air way was return air way at the time.

On the whole, the explosions had traversed longer distances of intake air ways than other parts of the mines, in some cases being entirely confined to such roads. That is to say the roads least likely to contain fire-damp were most affected.

Experience in mines would justify the expectation that an immensely greater proportion of explosions of fire damp would extend along the return air ways than along the intake air ways, whereas the reverse was the case in these explosions.

In the North of England, where this feature had long ago been observed, it has been customary to say with what has been termed "*the unlearned wisdom of experience*" that explosions of fire-damp always faced the fresh air, or that the gas sought the purest air.

In some of these explosions it was observed that the blast on arriving at points on the intake air ways where the air current split, had afterwards traversed one of the splits only. If the air current, before dividing, and in one of the splits, was in an explosive condition through the presence of fire damp, how did the other split escape being in a similar state? In one case it was observed that the split which escaped was a continuation of the straight line which was the course of the explosion up to that point, the split traversed by the explosion deflecting to one side.

In Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9, so far as a judgment could be formed, no person in the mine was in a state of alarm at the moment of the explosion.

In No. 10 the mine was on fire, and all the ordinary workmen had left the pit. The persons who were in the mine at the time of the explosion, engaged in isolating the fire, were, however, under no apprehension of a large explosion taking place likely to injure them; they were 600 yards from the fire.

It does not seem possible in the first nine cases, that *fire-damp could have entered the air currents in such* volume as to have made the explosions possible without the officials or workmen observing it.

In Nos. 1, 2, 3, 4, 5, 6, 7, 8, and 9, a shot was fired, and was the point of origin of the explosions; had fire-damp been present in the air current in sufficient quantities to make the explosions possible through its agency alone, it is highly improbable that any shot would have been fired. In the collieries where the ten explosions given in the table, occurred, safety lamps only were used at the working face, and in some of them also on the intake air ways, therefore *we must go to other explosions for a con*dition which supplies a negative reason why fire-damp is not the principal factor in some large explosions.

In many mines worked entirely, or nearly so, with naked lights, a great explosion has swept over the whole pit. Scotland affords an example of this in the explosion at Blantyre in the splint coal. It does not seem possible that any great area of a seam in which naked lights are scattered here and there could be so charged with fire-damp as to render an extensive explosion possible. A sudden fouling of the air current from any cause would lead to an explosion at the first open light encountered, and so would limit its extent. Yet at Blantyre, Clifton Hall in Lancashire, and Llanerch in Monmouthshire, and in many other cases, the mines were working with open lights, and all at once an explosion traversed the whole seam, causing in the cases just mentioned the death of 207, 178, and 176 persons respectively.

On exploring the mines after the occurrence of the explosions given in the table, there was no evidence of any outburst of gas or failure of the ventilation to account for the presence of fire-damp in sufficient quantity to cause the explosions. In No. 9 a single issue of fire-damp could have explained the explosion. In the other cases the course taken by the blast could not be explained by supposing that fire damp had entered the air current at any particular point; on such an assumption roads that should have been traversed were missed out, and roads were traversed that should have escaped. By no reasoning could the explosions be ascribed with any degree of probability to fire-damp only.

The positive reasons that support the view that coal dust was the principal factor in these explosions are as follows:—

The intake air ways were in all the cases, except No. 9, also used as haulage roads. In Nos. 1, 2, 3, 4, 6, 7, 8, and 10, mechanical haulage was in use on these roads, the main and tail rope system in all except No. 7, where the endless chain was in use. In No. 5 horses were employed. These roads were dry, they were traversed by large currents of air, and coal dust was blown off the trains of laden hutches passing often at high speeds, in the opposite direction to the air current. The result was that fine coal dust accumulated on the roof and sides, as well as coarser dust on the floor. Near the downcast shafts coal dust, carried down with the air from the screens, assisted materially in forming these deposits. The writer has not seen a road in a colliery in Scotland containing so much of the upper or wind borne dust as occurs on similar roads in the dry mines of the north of England. These dust laden, intake air roads were the roads principally affected *by the explosions, and, as already stated, in Nos. 1, 2, 4,* and 7 the explosions were entirely confined to them. In Nos. 1, 2, 4, 6, 7, and 8, the explosions originated on them.

The inner portions of the haulage roads, where the laden hutches, drawn by horses and ponies moved at slower speeds against feebler currents of air, contained little of the upper dust, and often the coal dust on the floor was much mixed with stone dust. The explosions were often checked on reaching such points.

In some cases, however, where these roads and the *working face contained a considerable quantity of coal* dust they were traversed by the explosions.

The explosions were in many cases stopped by damp ground. This was specially noticeable with regard to the explosions which extended to the downcast shafts, which was the case in Nos. 2, 3, 4, 5, 6, 7, 8, and 10. Where the downcast shafts were wet the explosions were arrested and did not cross them. In No. 2 the shaft was dry, and the explosion crossed it. In No. 3 the downcast shaft was very dry, and the explosion entered it and extended upwards to the surface, and downwards to four levels below. A dampness in the floor, it was observed, was not sufficient to arrest an explosion if upper dust existed.

In Nos. 3, 5, and 9 short lengths of the return air ways were affected principally next the working face where coal dust was present in quantity greater than is usual in such roads. The return airways on the whole could be said to be free from coal dust, and were not so dry as the intake air ways. At Altofts the return air ways were used as travelling roads for the colliers, and were full of stone dust ground up from the floor of the seam.

If the explosions were caused by the combustion of coal dust, the absence of alarm on the part of the workmen can readily be understood. The mines were in their normal state up to the moment of the explosion, and there was no new condition present calculated to cause alarm.

Naked lights could be in use all over a dusty mine and be a source of no immediate danger, although the necessary elements for propagating an explosion in the shape of coal dust resting on the floor, roof, and sides, and pure air were everywhere present.

The fact that some of the explosions were originated by the firing of a shot, is strong evidence that the air current *was not in an explosive condition from the presence of* fire-damp alone where the shots were fired, and affords some presumption that coal dust, either alone or in conjunction with such a proportion of fire damp as not to be considered dangerous by the person igniting the shot, was the agent first inflamed, as the danger of coal dust is not understood.

The personal experience of the writer points strongly to the preponderating influence of coal dust in large colliery explosions. How far this may be true for other large explosions, it is in many cases now almost impossible to say. *Until a few years ago coal dust was not recognized as a* factor in these disasters and in published accounts of earlier explosions, it is only mentioned incidentally. The explosions were always referred to fire-damp, and theories to account for its presence in sufficient quantity by a sudden outburst, the leaving open of ventilating doors, or some other cause, were put forward with more or less confidence.

There are, however, so many points of resemblance between the explosions briefly described and most other large explosions that the writer does not hesitate to express the opinion that in almost all widespread explosions the influence of coal dust has been predominant.

It is not, however, probable that so large a proportion of other large explosions have been caused by coal dust in air practically free from fire-damp being the agent first inflamed, as in the cases tabulated. Fire-damp ignited by the flame of a naked light or safety lamp or a mixture of coal dust and air containing a small percentage of fire-damp ignited by the flame of a shot, have probably been the origin of most large explosions.

The experimental investigation of the influence of coal dust in colliery explosions has been undertaken by individuals, committees, and Government Commissioners, both at home and abroad.

(*) This explosion, as well as Nos. 2, 3, 4, 5, and 6, in Table 1., are described in detail in a book entitled "Explosions in Coal Mines," prepared by Mr. W. Atkinson and the writer.

Mr. H. Hall, H M Inspector of Mines for the West Lancashire District, and Mr. Clark, mining engineer, described in a paper read before the North of England Institute of Mining Engineers, in June, 1876, some experiments they made with coal dust in a mine from the surface. The mine was 15 yards long, and 30 feet sectional area. They scattered coal dust on the floor and fired a cannon at the face to represent a blown-out shot. The most decisive result obtained by them may be given in their own words:—

"Coal dust having been scattered on deals the whole length of the slant (the hull being very wet), fired 2½ lbs. powder in this case flame issued strongly at the mouth of the slant, having travelled 45 yards. The blast was very fierce and would certainly have proved fatal to any one struck by it in its course."

In 1890 Mr. Hall experimented by firing a small cannon at the bottom of shafts after coal dust had been emptied into them, and caused explosions extending to the surface, or in one instance 180 yards.

These are the only experiments on a large scale in Great Britain.

Mr. Wm Galloway, who was probably the first to recognize the great influence of coal dust in large explosions, has conducted and published the results of many experiments on a small scale, in which he demonstrated the inflammability of coal dust. The Chesterfield and Derbyshire Institute of Engineers conducted experiments on a small scale, but obtained no very definite result, and appear to have been led by the negative results obtained to underestimate the importance of the question

Sir F. A Abel carried out experiments with coal dust on a small scale, at the request of the Home Secretary, in connection with the enquiry into the Seaham colliery explosion (No. 2 in list). He obtained no decisive result as regards the inflammability of coal dust and air alone, but he discovered, as already mentioned, the effect of dust, as dust and apart from its inflammability, in promoting the inflammation of mixtures of fire-damp and air.

He also conducted some experiments in larger galleries with coal dust and blown out shots, which showed that coal dust "will feed the flame projected by a blown-out shot so as to carry it on to a comparatively considerable distance."

The most important experimental work in connection with this question is that of the Prussian Fire-damp Commission, a translation of whose report will be found in vol. 34 of the Transactions of the North of England Institute of Mining and Mechanical Engineers.

The experments were made in an elliptical gallery, 167·3 feet long, and having a sectional area of 17½ square feet. A side gallery 32·8 feet long was added to the main gallery at a later period. Shots were fired at one end of the gallery from cannons to represent blown-out shots. The Commission sum up the result of their labours at considerable length. They state:—

1—"The *presence of coal dust* in more or less abundance in the immediate vicinity of the working face, *gives rise to more or less considerable elongation of the flame* projected by a blown-out shot, *whether small quantities of fire-damp be present in the surrounding air or not.*

2. *a*—"*In the complete absence of fire-damp the elongation or propagation of flame is generally of limited extent*, however far the deposits of dust may extend in the mine ways.

b—"*There are, however, certain descriptions of coal dust which*, if ignited by a blown-out shot, will not only *continue to carry on the flame, even to distances extending considerably beyond the continuance of the dust deposits*, but will also *give rise to explosive phenomena or results in the complete absence of any trace of fire-damp* which, in character and effects, are similar to those produced with some other dusts in air containing 7 per cent of fire-damp.

3. *a*—"*All the phenomena produced by the burning of and propagation of flame by coal dust are intensified by the presence in the air of small proportions of fire-damp.*

b—"*Certain dusts* which, under favourable conditions, appear to have the power of propagating flame to an indefinite extent in a dust-laden area, the air being free from fire-damp, *will, if only sparsely suspended in air containing fire-damp in some proportion below 3 per cent., render such a gas-mixture susceptible of explosion by a blown-out shot.*

4—"Special experiments, in which the branch gallery, described as opening into the main gallery near its extremity, was charged with a fire damp mixture (retained by brattice cloth), demonstrated that *a coal dust ignition or explosion developed in the complete absence of fire-damp, can communicate ignition to an explosive gas-mixture existing at a very considerable distance from the point of first ignition.*"

The Royal Commission on Explosions from Coal Dust in Mines, now sitting, will probably experiment on a large scale. From the volume of evidence issued by the Commission it appears probable that an artificial gallery, 200 yards in length, will be erected. This length will not be sufficient to test all the questions that arise. The writer's suggestion to the Commission was that some experiments should be made in a gallery not less than half a mile long.

From actual observations in mines it appears that a coal dust explosion proceeds from 50 to 100 yards from the point of origin before developing its maximum force. It is doubtful if this can be illustrated in a gallery 200 yards long The arresting of a coal dust explosion, travelling with maximum force and velocity, by a space free from dust, could not be tested in such a gallery.

Remedial Measures.

The first step in this direction is to obtain a proper conception of the causes of explosions in mines. The danger arising from fire damp is well known, and also the precautions necessary to prevent its accumulation and ignition, such as sufficient ventilation and the absence of naked flame The danger of coal dust is not so generally understood or admitted, but it is hoped that this will be secured by the labours of the Royal Commission now sitting.

The danger arising from coal dust in mines may be met (1) by precautions to prevent its ignition, and (2) by the adoption of means to prevent its accumulation or to render it innocuous.

The formation of a cloud of coal dust in mines and its subsequent ignition is practically caused by the disturbance and flame attending the explosion of shots or of mixtures of fire-damp and air; both of these will, it is believed, under some conditions, raise and inflame a cloud of coal dust in air, and initiate a coal dust explosion which becomes self-supporting.

Most shots are fired at the working face, and in mines deep enough to be dry and dusty some fire-damp is nearly always present in the air in such situations, and fire-damp may be liberated by the shot: the coal dust, however, is confined to the floor, and is not so fine as the wind-borne dust on main haulage roads. At the working face a blown out shot fired near the floor, or pointing to the floor, is most dangerous, and the dust must be present in considerable quantity before a coal dust explosion is possible, and then the effect of the probable volume of fire damp present in the air is to be considered.

On main haulage roads, after their completion, it must be noted comparatively few shots are fired, and where fire damp is practically absent coal dust of the finest character is often found on the roof and sides, as well as coarser deposits on the floor, and strong currents of air are usually present to sustain any cloud formed.

The effect of a shot in disturbing dust on such roads is two fold. The powder gases rushing from the shot agitate the air in its vicinity, and shock or tremor is communicated to the solid sides of the passage. At the working face, the first cause only operates. Any tremor given to the floor on which the dust there rests would have no effect in raising a cloud; but where dust is on the roof and sides as well as on the floor, both causes assist in forming a cloud.

The combined effect of these conditions appear to make it much more dangerous to fire a shot on an old haulage road, where there is much dust, than at the working face. Nos. 1, 2, 4, 6, 7 and 8 explosions were, it is believed, caused by shots which were not blown out, fired in stone on old intake and haulage roads where the air was practically free from fire-damp.

Nos. 5 and 9 explosions were caused by shots fired in stone at the working face. In these cases there was an unusual quantity of coarse dust on the floor near the shots, and there would probably be from 1 to 2 percent of fire-dam, in the air. In No. 5 the position of the shot hole could not be determined; in No. 9 the shot was partially blown out, and pointed to the floor.

The raising of a cloud of coal dust by shots may be prevented by removing or damping the dust in their immediate neighborhood, as is required by the present Mines Act, without resorting to any general system of removal or damping.

The use of a flaming explosive in conjunction with some material to kill the flame, or the use of a flameless explosive (if such exists) are remedies adopted.

The danger arising directly from explosions of fire-damp and air is a sufficient reason for adopting every reasonable precaution to prevent their occurrence. In dusty mines, where such explosions may be indefinitely extended by coal dust, even greater precautions are necessary.

No. 3 explosion was probably originated by a local explosion of fire-damp at an open light; No. 10 was caused by fire-damp ignited by the flame of a fire. The fire-damp had collected in passages near the working face, from which the air current had been cut off by the erection of a stopping in the intake in order to isolate the fire, the mutual explosion so cause being extended to the downcast shaft by coal dust.

Means to prevent the formation of dust deposits, or to render them innocuous, will be briefly glanced at.

Main roads are watered on the floor, and in some cases mechanical sprayers are used, so as to damp the roof and sides as well. Water pipes are laid along the main roads, the water issuing under pressure as a fine jet at intervals. Compressed air is used in connection with the water so as to secure a fine spray, and both damp the roads and saturate the air current with moisture.

In some cases the water pipes are simply provided with cocks at intervals, to which a hose pipe is attached when watering is necessary.

List of explosions causing loss of life resulting from the ignition of fire-damp and coal dust in the collieries and Mines in the United Kingdom under the various Coal and Ironstone Mines Regulation Acts.

Year.	Number of Explosions, arranged according to Loss of Life.											Total No. of Explosions.	Total Lives Lost.
	1	2	3	4	5	6	7	8	9	10	11 or more Lives—Each Explosion given separately.		
1851	70	12	5	5	—	1	1	—	2	—	13, 35, 52, 61.....	100	321
1852	70	10	—	3	1	2	—	—	—	1	12, 22, 36, 65	91	264
1853	53	12	2	1	2	1	—	—	—	1	11, 20, 58.....	75	202
1854	62	9	4	3	—	2	1	—	—	—	89.....	82	212
1855	65	17	5	3	1	—	1	—	—	—	....	92	138
1856	54	8	3	1	1	—	—	—	—	—	11, 11, 12, 114.....	71	236
1857	43	13	5	5	1	—	—	1	2	—	13, 40, 189.....	73	377
1858	44	10	8	3	—	1	—	—	—	—	12, 19, 25, 53.....	70	2.5
1859	53	10	3	2	1	—	—	—	—	—	.....	69	95
1860	47	8	7	—	—	—	—	—	—	—	12, 13, 13, 22, 76, 142..	68	362
1861	45	12	—	1	—	—	1	—	1	1	13, 13.....	63	125
1862	49	5	1	1	—	1	—	—	—	—	16, 47, 59.....	60	194
1863	42	11	1	2	—	1	—	—	—	—	13, 15, 26, 39.....	61	173
1864	48	13	4	1	1	—	1	—	—	—	....	68	102
1865	44	7	8	3	1	—	—	1	—	—	26, 34.....	66	167
1866	47	14	1	3	—	—	—	1	—	—	12, 24, 27, 30, 38, 91, 334	73	654
1867	41	9	7	—	—	—	1	—	—	—	12, 14 178.....	61	291
1868	36	5	1	1	—	—	—	1	—	1	26, 62.....	47	159
1869	32	5	2	2	1	1	1	—	—	—	11, 27, 37, 53, 59.....	49	261
1870	38	13	3	1	1	1	—	—	2	—	19, 19, 20, 30.....	63	193
1871	29	9	—	3	1.	1	—	1	1	—	19, 26, 26, 38, 70.... ..	50	266
1872	52	4	2	1	—	1	—	1	—	—	11, 27, 34.....	64	156
1873	28	8	—	2	1	2	2	—	—	—	18.....	44	101
1874	33	6	—	2	1	—	—	—	—	—	15, 17, 23, 54.....	46	167
1875	24	6	2	2	1	—	1	—	—	—	16, 23, 43, 143.....	40	287
1876	26	10	3	1	2	1	—	—	—	—	23.....	44	98
1877	35	3	1	1	—	—	—	1	—	1	18, 18, 36, 197	46	345
1878	17	5	3	—	—	1	1	—	—	—	17, 23, 43, 189, 268....	32	589
1879	21	5	2	—	2	2	1	1	—	—	21, 28, 63.....	37	186
1880	14	4	—	2	—	2	—	—	1	—	62, 101, 120, 164.....	27	498
1881	24	4	—	1	—	—	—	1	—	—	25, 48.....	32	117
1882	19	4	1	4	1	—	1	—	—	—	13, 32, 37, 45, 74.....	35	259
1883	15	4	1	1	2	—	—	—	—	—	20, 68.....	26	135
1884	21	4	2	—	—	1	—	—	—	—	14, 14.....	30	70
1885	17	3	—	—	—	—	—	1	1	—	42, 81, 178..	25	341
1886	12	2	1	1	—	—	—	1	—	1	22, 28, 38.....	21	129
1887	13	3	5	—	—	—	—	1	—	—	39, 73.....	24	154
1888	11	1	1	—	1	—	—	—	—	—	30.....	15	51
1889	8	4	2	1	—	1	—	—	—	—	20, 23, 64.....	19	139
1890	16	3	—	—	1	—	—	—	—	—	87, 176.....	22	290
1891	12	8	1	—	—	—	—	—	—	2	....	23	51
Totals	1430	303	97	63	23	24	14	12	10	8		2104	9172

11	(5)	20	(4)	30	(3)	42	(1)	59	(2)	74	(1)	142	(1)	
12	(6)	21	(1)	32	(1)	43	(2)	61	(1)	76	(1)	143	(1)	
13	(8)	22	(3)	34	(2)	45	(1)	62	(2)	81	(1)	164	(1)	
14	(3)	23	(5)	35	(1)	47	)1)	63	(1)	87	(1)	176	(1)	
15	(2)	24	(1)	36	(2)	48	(1)	64	(1)	89	(1)	178	(2)	
16	(2)	25	(2)	37	(2)	52	(1)	65	(1)	91	(1)	189	(2)	
17	(2)	26	(5)	38	(3)	53	(2)	68	(1)	101	(1)	207	(1)	
18	(3)	27	(3)	39	(2)	54	(1)	70	(1)	114	(1)	268	(1)	
19	(4)	28	(2)	40	(1)	58	(1)	73	(1)	120	(1)	234	(1)	

At some collieries the laden hutches are watered at the engine landings. More attention is paid to the construction of the hutches, so as to prevent coal and coal dust being shaken out of them.

By the use of steam the temperature of the air descending the downcast shaft has been raised to the temperature of the mine and at the same time saturated with moisture; the air current passing around the mine then ceases to have any drying power.

Hygroscopic or water-absorbing salts have been sprinkled on the roads to secure dampness.

Coal dust from the screens on the surface should be prevented as far as possible from descending the downcast shaft with the air current.

The above table shews the number of fatal explosions due to fire-damp and coal dust, and loss of life occasioned thereby, as registered in the reports of the Inspectors of Mines, from the year 1851 to 1891, both inclusive. There are 2,104 separate explosions, causing the loss of 9,172 lives, the average death rate per explosion being 4·36.

It has occurred to the writer that some argument in support of or against the coal dust theory may be founded on these figures.

It will be observed that the number of explosions causing the loss of one life is 1,430, of two lives 303, and so on to the final explosion causing the loss of 334 lives. The rate of decrease of the number of the explosions, as the rate of their fatality increases, is shown in a diagram (Plate I.) The number of lives lost by an explosion is, roughly speaking, in proportion to the area of the field of the explosion.

Is the curve shewn in the diagram such as might be expected if the explosions were all due, or nearly so, to one cause—the explosion of fire-damp and air? If this can be answered in the negative, can the curve be explained on the assumption that there are two causes, the other being coal dust?

Three assumptions may be made with respect to these figures and the diagram founded thereon:—

1st—That the explosions are all due to fire-damp.

2nd—That the explosions are all due to coal dust.

3rd—That the explosions are due to both agents.

The first assumption—that the explosions are all due to fire-damp—has been held until recently, and is still held by some persons, modified by the admission that coal dust has aggravated or intensified some explosions. On this assumption there appears to be some difficulty in explaining the diagram. Why should there be such an extremely rapid decrease up to a certain point of the number of the explosions as their fatality increases? If fire-damp is the cause of the large number of small explosions causing one, two and three deaths, and also of the monster explosions, might not a considerably greater number of intermediate explosions have been anticipated. A reason that might be suggested is, that the use of safety lamps renders a large explosion possible in some mines by enabling a great length of air current to become explosive before it is ignited, while the use of naked lights in other mines causes the large number of small explosions. The explosions causing the loss of one life are undoubtedly nearly all due to fire-damp; this the writer can state from investigation of a large number of them. Had mines been free from coal dust probably the line in the diagram would have been terminated sooner; as the rate of fatality increases, so it is believed does the influence of coal dust.

The second assumption is clearly untenable. Many explosions occur in mines free from coal dust, such as damp coal mines, oil shale, ironstone, and occasionally in lead mines; it may be noticed, however, that in such mines large explosions do not occur. If coal mines had been free from fire-damp, the dust remaining the same, probably the line in the diagram would have been nearer a straight line.

On the third assumption the diagram may be explained bearing in mind the following facts:—Fire-damp is readily ignited, and as many mines yielding it in small quantity are worked with naked lights, local explosions due to it are not unfrequent. On the other hand the danger of fire-damp is well known, and if present in large quantity suitable precautions are taken. Coal dust is not readily ignited, and in the past no precautions have been thought necessary with regard to it, but if it is once inflamed it is likely to cause a large explosion, because it is present in dry mines continuously over wide areas, and in many large explosions the loss of life has been practically that of the miners underground.

The Ventilation of Fiery Mines.

(Paper by M. RATEAU, before the Societe Minerale de Saint-Etienne.)

Fire-damp gets into the mine in three different manners—while the coal is being got; by blowers; and by irruption of air from the old workings.

Disengagement of Gas from the Working Face.—Some coals disengage as much as twenty times their volume of gas; and, according to the nature of the coal, sometimes this disengagement is very rapid but at others slow. Sterile rock also disengages fire-damp, which is sometimes met with in salt and metalliferous mines, and even in quarries. While for a certain small extent of a given seam the disengagement of gas may be tolerably regular (except in the case of sudden outbursts), this is by no means the case under the following circumstances:—

Issue of Fire-damp by Blowers.—When the piercing of a cavity gives rise to a blower, which is greatly to be feared in the neighbourhood of faults, and also when mining operations in a lower height of workings disturb the equilibrium of measures at the sole of the upper height.

Irruption of Air from Old Workings.—When, in old workings, however well they may be gobbed, vacant spaces are left in which the gas may continue to be disengaged, long after working has ceased. Although old workings do not generally contain much gas, one cannot be sure that they do not. Gas from old workings may burst out in others being carried on, in two different manners—viz., by a general lowering of pressure in the mine and by a modification of the *regime* of the ventilation. As variation of the pressure in a mine, caused either by change in the external atmosphere or in the speed of the fan, is very slight and does not take place suddenly, this is not so great a cause of danger as the second, stated as follows by M. Rateau: "The old workings generally communicate with those in active operation by several orifices, so that an air-current is almost always set up, and sweeps away the accumulations of gas which have a tendency to form there. This is why they may not contain fire-damp. But such a *regime* of ventilation may be so set up that the pressures at the orifices of the old workings may be exactly balanced, when the air, having no longer a tendency to pass out, remains stagnant, and becomes charged with gas if any more be disengaged."

Ventilation Regime.—Variations in the *regime* of ventilation, occurring under these circumstances, brings about changes in the distribution of pressures at the orifices, and an air current is established on one side or the other, so that very soon all the air in the old workings, or nearly so, bursts into the workings in operation, and the danger becomes grave. Many accidents in but slightly fiery mines may perhaps be traced to this cause, for which an exceptional concatenation of circumstances is necessary; so that the precept should always be observed that *the ventilation regime of a mine should only be changed progressively and with precaution.*

Opinions differ as to whether it is best to wall up orifices communicating with old workings, or to ventilate them constantly so as to prevent accumulations of gas; and the Austrian Fire-damp Commission recommends that the lower orifices be stopped up, and the higher left open, so as to permit the gas to pass into the return air-current.

Classification of Fiery Mines.—While in France all fiery mines are subject to the same regulations, which is a simple mode of dealing with the question, though one open to numerous objections, the Austrian Firedamp Commission classifies them as: (1) Slightly fiery, which have less than 1 per cent. of gas (fire-damp and carbonic acid) in the return air ways (¼ cubic metre per second and per ton of coal got in twenty-four hours); (2) fiery, with from 1 to 2 per cent of gas; and (3) very fiery, with more than 2 per cent. Until exhaustive experiments shall establish a law for each mine, the author thinks it safest to keep to the present French system.

To be well rid of fire-damp it is indispensable to resort to mechanical ventilation, and three different methods may be employed for getting rid of fire-damp. Absorption of the gas by re-agents is impracticable, and drawing it off by pipes is difficult and not to be recommended, except in the case of blowers. The only really efficacious method of dealing with gas is to dilute it with a sufficient quantity of fresh air to render it harmless, and then draw it out of the mine; but the current must be judiciously distributed, so as to oblige the gas to mingle with the air employed to draw it off.

Necessity for Mechanical Ventilation.—Efficient ventilation should (1) circulate a sufficient volume of air to dilute the gas, (2) distribute the current and (3) oblige the gas to mingle with the air.

Volume of Air to be Circulated.—Since the inflammability of the mixture of gas and air only begins with a proportion of 6 per cent. of gas, it would theoretically be sufficient to circulate through the mine a little more than sixty-four times the volume of gas divided by six; but practically much more is required—first, on account of the dust, which increases the inflammability, and secondly, because a co-efficient of safety is necessary, on account of variations in the disengagement of gas and defects in the district of the air current. The same co-efficient of safety as that adapted for iron bridges—viz., 1 : 5 to 1 : 6—is generally admitted by fire-damp commissions, which recommend that there should never be in the return air ways a greater proportion of combustible gas than from 1 to 1·5 per cent.; but a mine with 1 per cent. of gas in the return air ways is certainly in a precarious condition, and there is every reason to reduce it below 0·5 per cent. A study of the return air in a mine and its variations may now be made easily and with sufficient correctness by means of the Pieler lamp and the Shaw grisoumeter; and this study, rather than the number of men or the quantity of coal raised, should serve as a basis for calculating the total quantity of air to be sent into the workings. In many cases this quantity is much greater than that obtained by simple natural ventilation, which is always insufficient when the seasons change; it is therefore, absolutely necessary to employ mechanical means for ventilation.

Distribution of the Air Current.—It is important that the air current search out and draw away the gas from all the nooks and corners of the mine; and the quantities to be sent into each part or place should equal the quantity of gas evolved from it. Besides the difficulty of ascertaining this quantity, there is that very complicated one of the manner in which the distribution can be effected. It is indispensable to have a stable distribution; wherefore the difference of pressures at the entrance and exit must be sufficiently great for differences of temperature underground not to reverse or even slacken the air currents. It is not sufficient for effective ventilation to have volume merely, there must also be a marked difference of pressure, which should not be less than 25 or 30 mm. (1 in. to 1¼ in).

Great care should be taken in modifying a regime long established, for a change introduced at a given point may exert its influence a long way off, and upset the ventilation of districts apparently removed from its influence. The use of secondary ventilators underground, as in the Blanzy colliery, is calculated to render great service, not only in the case of *cul de sac* workings, but also in certain districts that may with difficulty be put into communication with the general air current. In this way it is possible in order to avoid any awkward strangling of the main air ways to oblige the air current to make a complicated circuit through the action of the main fan.

Energetic Ventilation.—It follows that for fiery mines intense mechanical ventilation is required, giving as large a volume as possible with a considerable difference of pressure; and this is the conclusion arrived at by most fire-damp commissions, though it would appear that a contrary opinion prevails at Saint-Etienne. The opinion that mechanical ventilation is bad and that a large volume of air is not advisable is condemned beforehand by the many disasters in that district, especially during the last few years, all of which accidents have, without exception, occurred in mines with natural or feeble ventilation.

Necessity of Mingling the Gas with Air.—It is with great difficulty that fire-damp mingles with air on account of its extreme lightness. The ratio between the density of air and fire-damp—viz., 7 : 1—is greater than that between air and carbonic acid : (1 : 5); and it is well known (Grotto del Cane) that the latter gas remains a long time on the floor of workings without mingling with the air. In the same way does fire-damp rise to the roof, collect in cavities, and stay there, strong air-currents not being able to dislodge it. As it is not always possible to avoid leaving cavities, M. Rateau recommends the use of portable fans, provided with flexible hose and nozzle, for dissipating accumulations of gas. Each of these tertiary (*de troisieme ligne*) ventilators would be wheeled about the mine by two men with the sole object of dissipating accumulations of gas.

Principal Ventilator.—The main fan may be either pressure or exhaust. The necessity for an upward current and of erecting the fan over a shaft not used for winding, generally leads to the exhaust system being employed; and, wherever that arrangement is not obligatory, the author is of opinion that the pressure fan should be preferred for the following reasons: Its first cost is less, it is easier to inspect, it chokes less readily and requires less frequent cleaning, besides requiring less force to drive, because the volume of air sent down is on an average 15 per cent. less than that brought up. Sometimes, especially in collieries subject to underground fires, reversible fans are put down; and this is a practice that M. Rateau considers recommendable if the fan be not required to work equally well in both directions, and if one (the exceptional) mode of action may be sacrificed.

During the last few years, in order to keep the mouths of the downcast and upcast shafts perfectly clear for winding, so as to secure a large output, fans have been erected underground. As an air lock is always required, there is no greater difficulty in arranging it on the surface than underground, while the expense in the former case would certainly not be greater. But a strong reason for never putting underground so essential an apparatus as a fan is that its inspection is in that case difficult and necessarily incomplete, while if an accident happen, the fan would certainly be injured, thus rendering it impossible to quickly re-establish the ventilation. The first underground fan was erected at the Shamrock colliery, in Westphalia; but the manager is so strongly impressed with the disadvantage of this arrangement that he has determined never to adopt it again.

Secondary Ventilators are worked by hand or compressed air engines, the latter being manifestly preferable, and in this case they are generally pressure fans. The author, however, *considers that there are many cases in* which it would be preferable to employ exhaust fans, on account of the difficulty of obliging the gas to mingle with air. Thus, instead of sending a current of fresh air against the working face of a level, it would be better to exhaust from a point a little in front of the face and near the roof, by a pipe suspended from the horizontal members of the timbering. As the current of fresh air would traverse the whole working, the latter is less exposed; and besides, the air, continually rising towards the orifice of the pipe, would draw along with it all the gas which it encountered, and which, therefore, would be drawn away. With the insufflation method, on the contrary, the gas disengaged from the face, drawn along by the air but not completely mingled with it, would soon become to a certain extent separated from it and remain in the spaces between the horizontals of the timbering. By placing the pipe in the upper part of the working there is also the advantage of arranging short branch pipes at intervals, for keeping up a constant circulation in the cavities. Even leakage in the main pipe would, to a certain extent, exert this effect. Another case in which exhaust fans are preferable is that in which the smoke from shots has to be drawn off. By exhausting the smoke it goes off through the pipe, and the air of the working is soon purified, whereas this is far from being the case with a pressure fan.

Tertiary Ventilators.—What M. Rateau calls *ventilateurs de troisieme ligne*, already referred to, are intended for dispersing accumulations of gas. Very small fans may be usefully employed to dislodge gas from cavities by air jets, and also to disperse accumulations in *cul-de-sac* mines temporarily abandoned, in which case the exhaust

fan is clearly indicated, though it should be used with precaution. In the first place such a working should not be cleared of gas all at once, because there would be danger, (as happened last year at Firminy) of causing an accident by vitiating the whole return air current. Besides, the gas does not mingle completely with the air; but a large part rises to the roof and fills all the spaces between the timbering. To obviate this source of danger the gas must be mixed with a sufficient quantity of pure air before allowing it to pass into the general current, so that, according to M. Favet, the difference of densities becomes so slight that gas has no longer a marked tendency to rise to the roof. This is practically carried out by M. Rateau's combined exhaust and pressure fan, that causes an intimate mixture of air and gas, which mixture may be led by a delivery pipe wherever desired. In the original paper a table of the results obtained by this apparatus is given which will draw 50 titres (176½ cubic feet) of gas per second and mix it with five or six times its volume of air.

Comparison between Fans and Furnaces.—The author demonstrates by mathematical formulæ that fans are much more economical than furnaces, and from his deductions compiles a table from which it appears that, at all depths of working, fuel consumption is much less for the former than for the latter, the difference being as 1 : 5 at a depth of 300 m. This is even greater where steam that has to be generated in a boiler—the first cost of which must be taken into consideration—is used instead of a furnace.

Ignition of Mine Shots.

(Colliery Guardian).

M. Janet opens his remarks on this subject in the *Annales des Mines* by observing that, if shots in fiery mines are not the most frequent cause of accidents, they, at any rate, lead to the greatest number of victims, while the labours of the French Explosives Commission, and especially the discovery (by M. Mallard and M. Le Chatelier) of new explosive substances capable of detonating, without igniting fire-damp, had done great service to the mining interest, and had also rendered the working of fiery mines much less dangerous.

As a consequnce of these labours a ministerial circular called upon the Prefects (chief administrative officers of the departments) to make obligatory the use of the new explosives, not only in fiery mines but also in those the dust of which is inflammable, while at the same time providing that the temperature of detonation shall not exceed 1,900 degs. Cent. in rock, nor 1,500 degs. Cent. in coal.

But, contends M. Janet, there is danger of igniting the gas, not only when the explosion takes place, but also when the fuse is lighted; and it is just this matter, so long neglected, wich constitutes a serious source of danger. In fact, except in a few collieries where shots are fired by electricity, the so-called safety fuse is used, ignited by *amadou*, or German tinder.

The French Explosives Commission pointed out the advisability of completely suppressing the use of safety fuse in fiery mines, and suggested the substitution of friction detonators and electricity. Those methods have not, however, come into general use, though some friction detonators have been used with good results. The objection to electricity, except in sinking shafts and driving large roads, is that the appliances for ignition are two heavy to be removed about easily, while currents of high tension may give out sparks capable of igniting the gas. So long, however, as the old fuse is employed there is every reason to reduce its dangers to a minimum, especially as regards the method of lighting it.

After describing the well-known "safety," the rate of combustion of which is stated to be from a metre to a metre and a-quarter per second, M. Janet gives the following as the causes by which fire-damp may be ignited by its means:—(1) By the incandescent substance used to light the end of the fuse, (2) by the sparks issuing from the end at the moment of lighting, (3) by the little explosions that the fuse may cause while burning, and (4) by the gases due to the combustion of the explosive, which appreciably precedes the detonation, when the fuse, penetrating too deeply into the catridge, is brought into direct contract with the explosive. This last cause of danger, which no appliance can prevent, has the great disadvantage of making the safety of the colliery dependent on the experience of a miner; but this disadvantage has been lessened since the firing of shots in mines subject to outbursts of gas has been entrusted to special hands.

The little explosions that may be caused by the normal combustion of the fuse also constitute a source of danger difficult to obviate; but the experiments of the French Explosives Commission have demonstrated that, if there be none of these little explosions, the mixture of air and gas is not ignited by the mere burning of the fuse, provided it be lighted outside the explosive mixture, safety, therefore, depending on the quality of the fuse. These little explosions result from two very distinct causes, viz., (1) the presence, in the central core of powder, of grains of appreciable size, and (2) insufficient strength in the outer covering. When the core is made of very fine touch-powder it burns gently at the rate mentioned above; but a single grain only will cause a slight explosion, which may burst the covering and emit flame.

All powder used for fuses should therefore be very carefully sifted, and the covering should consist of several thicknesses of material, while the best quality of fuse should always be chosen for fiery mines. The white "safety" is preferable to the black, because the tar used to coat the latter might be ignited by a little explosion. As companies cannot have the fuse inspected, as rails are, during manufacture, they should, at any rate, test ten lengths, a metre long, out of a thousand metres, by burning it in the dark; and, if the slightest explosion occur, reject the whole lot. Fortunately, the length of fuse outside the shot hole is very short, thus reducing the chance of danger, for explosions occurring inside the hole can do no harm, because of the tamping.

It is generally belived that *amadou* will not ignite fire-damp, though no direct experiment has, to the author's knowledge, determined the question; and sparks of flint and steel have been proved by the recent experiments of the French Explosives Commission to be without danger in an explosive mixture. The practice of lighting German tinder through the gauze of a safety lamp is, however, likely to cause serious danger from several causes; and so are the sparks emitted from the ends of the fuse when lighted by the tinder.

The emission of sparks from the end of the fuse projecting from the shot-hole is of short duration; and it is probable that a sufficient co-efficient of safety is afforded by admitting that the sparks do not ignite after the fuse has bnrnt 10 cm. (4in.) All, therefore, that is required to suppress danger from this source is to arrange a close chamber, or at any rate one enclosed by wire gauze, for lighting the fuse in such a manner as not to fire an explosive mixture of fire-damp. The appliances available for fulfilling this condition may be divided into two classes, viz., those serving for an indefinite number of lightings, and which therefore must be removed when such lighting is accomplished; and those which, serving for only one lighting, are left in place, permitting the fireman to retire at once after effecting the ignitions.

The appliances of the first category are evidently very inferior as far as safety is concerned. As it is necessary to wait until the fuse has burned 10 cm. (4 in.) before it ceases to be dangerous, and as the rate of combustion is about a metre per minute, six seconds must be allowed to elapse between the lighting and removing the apparatus; and it is too much to expect the fireman to wait so long, when any irregularity in the composition of the fuse may bring about an explosion that might blow him to atoms. Instead of counting six seconds, however, he may hold the fuse 10 cm. from the end, when he will become aware, dy the sensation of heat, that the powder has burnt up to that point. He can then remove the apparatus; and this course is preferable on account of the irregular burning of the fuse. In any case, it is necessary to leave 20 cm. (8 in.) to allow a good margin for the possibility of too rapid combustion; and this has the disadvantage of doubling the chance of a defect in the fuse occurring in that length.

M. Janet then describes at some length, and aften with the aid of diagrams, several appliances which permit of lighting the fuse without the possibility—theoretically—of igniting an atmosphere impregnated with gas.

Lighting by an Incandescent Substance.

M. Lagot, a miner at Saint-Etienne, proposed, in 1881, the use of a coal impregnated with saltpetre, burning wtthout flame. The apparatus is so arranged that when one piece of coal is burnt it will light another, thus affording an incandescent body for the whole day without touching the tube. The end of the fuse is pushed into the tube until it touches the nitrated coal. As the orifice is of the same diameter as the fuse, the flame remains enclosed in the tube, which must not be withdrawn until the fuse has burnt far enough not to be dangerous. This method was tried at the Lalle Colliery, the engineer of which concluded that it might be employed with safety by a man specially appointed for the work, but not by the miners generally. There is, however, the danger of a small piece of incandescent nitrated coal falling out of the tube and igniting the coal about the floor, while sometimes one piece of nitrated coal fails to ignite the next, and the fuse should fit tightly in the orifice, so as to prevent the former from igniting the explosive mixture.

Ignition by Chemical Reaction.

A substitute for the incandescent body may be found in two substances capable of causing, by their simple contact, a sufficient elevation of temperature to fire the charge. Messrs. Davey, Bickford, Smith and Co., of Rouen, supply a lighter, consisting of a thin metal tube, open at both ends, containing a small glass capsule with a little sulphuric acid. The capsule is closed by the blowpipe and surrounded by a piece of muslin impregnated with chlorate of potash and sugar, kept in place, on one side by a groove in the tube, and on the other by a piece of fuse, forming cushion, and leaving a sufficient length of tube free to receive the end of the fuse in communication with the shot. The other end of the tube is closed by an obturator, which permits the passage of the gases generated by the combustion of the ignition charge and of the fuse, but no sparks or flame. The fuse is fixed in the tube and the capsule crushed by a special pair of pincers, when the acid, encountering the chlorate of potash, ignites the muslin and then the powder of the fuse, thus warning the fireman to shelter. These lighters have been tried, generally with success, at the collieries of Anzin, Ferfey, Bességes and Carmaux; and though there have been misses, blowing out and bursting of the tube, which may be accounted for by an inefficient application, the author's experiments lead him to the conclusion that this appliance is calculated to render service in careful and experienced hands.

Ignition by a Fulminate.

This system, which consists in inserting the fuse in a pistol barrel and igniting it by a percussion cap, is employed at the Lens Collieries, in the Pas-de-Calais. The gunmetal barrel of the pistol is taper in form, so that the fuse can be inserted tightly. To prevent the fuse from being blown out the pistol barrel is surrounded by a cylindrical chamber to receive the gases from the explosion of the cap and the combustion of the fuse. This appliance generally answers well and makes few misses: but the fireman must not remove it until he feels by the heat that the fuse has burnt to 10 cm. (4 in.) from the end.

Ignition by the Safety Lamp.

A safety lamp invented by Messrs. Johnson and Howatt, has been experimented upon, at the request of the French Explosives Commission, by the Anzin Company, with favourable results. In order that the lamp may remain safe, it is necessary that the flame be carefully isolated from the surrounding atmosphere. The fuse is therefore introduced through a tube, which traverses the lamp from top to bottom, and is provided at the top with a cylindrical cap and a double gauze. The ignition is effected by an iron wire, 1mm. in diameter, heated to redness in the flame of the lamp and brought by a mechanical paw or finger into contact with the end of the fuse. The holes both for the wire and the fuse are provided with obturators displaced only during insertion. M. Petit, engineer at the Anzin Colliery, has proposed some modifications, including the addition of a flange to the wire. The fireman must also in this case keep the fuse in the tube until combustion has gone on for 10 cm.

Pneumatic Ignition.

This system is founded on the well-known lecture demonstration of rendering a piece of tinder incandescent by the compression of air in a close chamber; and the elevation of temperature is sufficient to fire gunpowder. An appliance depending on this principle has been devised by M. Bourdoncle, mechanic, at Decazeville, in Aveyron. There is small air pump, the piston rod of which terminates outwards in a rounded disc suitable for receiving a smart blow with the hand, to effect the compression of air. The barrel is screwed into the wide foot, in which is a central hole for introducing the fuse; and a tight joint is made by intercalating an indiarubber washer between the barrel and its foot, which washer is, by the screwing up, pressed firmly against the outside of the fuse. The foot has also a lateral hole to allow the fuse to pass and prevent it from being injured by the blow. In this case also it is necessary to wait six seconds before removing the apparatus, which has been tried at the Issards Colliery, in the Decazeville district, at the request of M. Castelnau, Ingénieur-en chief des Mines—that is, Government mining engineer of high grade—at Rodez. According to the report of M. Tarragonet, manager to the Société des Aciéries de France, to whom the colliery belongs, this simple igniter has given very satisfactory results, and has therefore been adopted in all the company's fiery mines. The blow must be a smart one to effect ignition, which is favoured by unpicking the outside of the end of the fuse, so as to expose the powder as much as possible. When these precautions are taken by one who has had a little experience with this appliance, which is easily kept in order, it makes very few misses.

While the last-named igniter, the Lagot tube, the Lens pistol and the Johnson and Howatt lamp, all have the disadvantage of obliging the fireman to stay for a few seconds near the shot to be fired, the chlorate of potash igniters permit of his retiring immediately. On the other hand the latter are expensive, owing to the high price of the chemical substance, while the maintenance of the others is insignificant, even when taking into consideration the extra length of fuse required to give a sufficient co-efficient of safety.

Coal Washing at Louisenthal.—The new coal washing floor at the Serlo colliery at Louisenthal, near Saarbrucken, commenced regular work in 1890, and experience has shown that several modifications were necessary. The very greasy character of the shale mixed with the coal presents great difficulties in the way of the clarification of the water with a view of its being used over again. After being used several times the water becomes so heavy that the jigging of the coal is interfered with. Experiments made with a view to obviate this difficulty have as yet given no satisfactory solution. The arrangement by which the coal passed from the jigging machines to the bins, by means of chutes, was also found to be disadvantageous. These chutes were built horizontal for a distance of some three yards, and the coal had to be forced along by a powerful stream of water. Consequently a large quantity of water was carried with the coal to the bins, so that the proportion of water in the lump coal was 5.32 per cent., and that in the smaller coal 6.07 and 9.01 per cent. respectively. This disadvantage has been obviated by the introduction of perforated metal band conveyors, the proportion of water being thus reduced to 3.71 per cent. in the lump coal, and to 5.03 and 6.04 per cent., respectively, in the smaller sizes.

The "Robb-Armstrong" Engine.

We illustrate on this page a new single-valve automatic engine recently brought out by the Robb Engineering Co., of Amherst, Nova Scotia. In general appearance it does not differ greatly from several popular high-speed engines, and no radical departure has been made in principles of construction, the aim being to combine as many as possible of those points which have proven best in practice, with such improvements in details as have been suggested by observation and experience with other engines. In other words, it is not an attempt to develop a new species, but to advance one step in the evolution of that already highly developed machine, the American high speed engine. The following is a brief description of the main features.

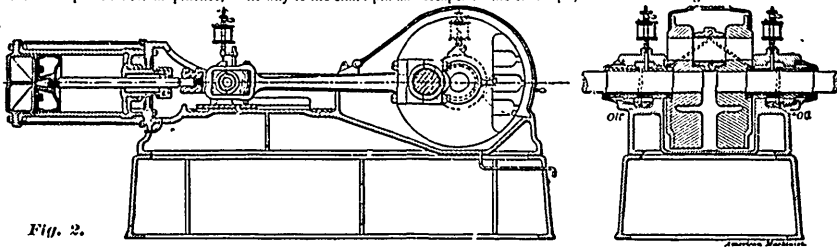


Fig. 2.

The frame is of the "Porter" type with double-disk crank; it has considerable sectional area, carried well above the centre line and is particularly thick at the top, thus bringing the metal in the direct line of strains between the cylinder and shaft bearings. The engine weighs a little over 100 pounds per horse power, not an unusual weight, but the metal is distributed to give the greatest attainable stiffness, and without much regard to the "anvil principle," the foundation being expected to furnish all the weight required in that direction at less cost.

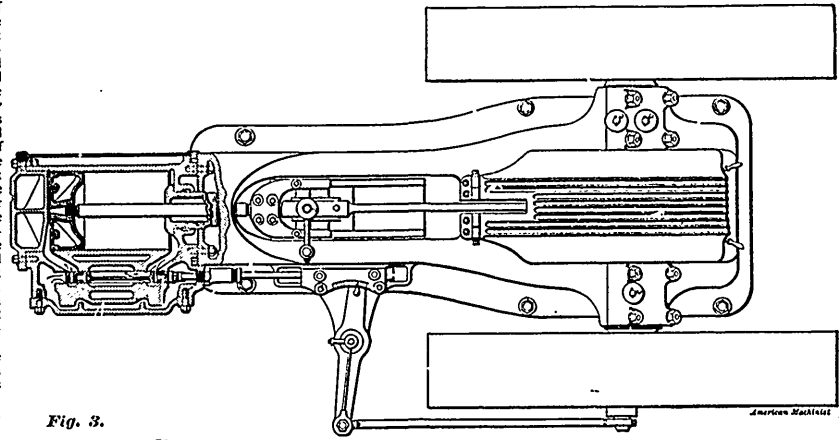
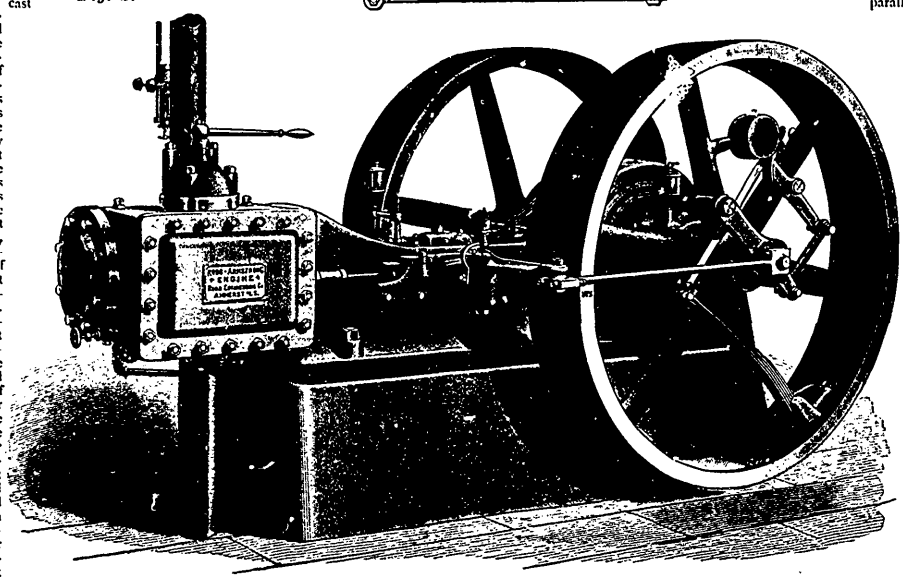


Fig. 3.

The crank is "built up of cast disks and forged steel pin and shafts, the peculiar arrangement of the crank permitting the fits of the shafts and pin in the disks to be very long, without separating the shaft bearings unduly, as is shown in the cross-section at the right of fig. 2; the counter-weight is of equal moment with the reciprocating parts. The shaft bearings run in cast iron shells, babbitted; they are not provided with means of adjustment for wear. The bearings are finished by grinding operations of great delicacy, and are round and parallel within a limit of variation smaller than the average machinist will usually detect, even with the aid of the micrometer. The shafts are made to gauge, and the shells are interchangeable, as are the other parts of the engine; hence, a duplicate set of shells may be kept for emergencies. The crank is covered by a cast-iron case, shutting it completely in except at the slot through which the connecting rod works. The crank disks are without the usual finished flanges on the periphery, the crank case being designed to have a substantial and finished appearance, and free access is given to the crank-pin box, when the hinged crank case is raised. The crank-pin is oiled through two ¼" holes, one extending from each side of the crank to the center of the crank pin, all oil wasting from the inner ends of the shaft bearings being instantly carried to the crank, while all oil wasting from the outer ends of shaft bearings is caught, and by a ring riding on the top of shafts, and dipping into the oil below, is returned again and again to the bearing, until it finds its way to the crank-pin and escapes to the crank pit, to be drawn off and filtered. In practice the crank-pin does not need oiling other than as stated, but a sight-feed oil cup is provided in addition to those oiling the shaft bearings, which will, if desired, feed oil direct to the crank-pin through one of the ¼" holes before mentioned.



THE "ROBB-ARMSTRONG ENGINE.

The fly-wheel governor is a modification of the "Straight Line," and, together with the valve, is used by arrangement with the Straight Line Engine Co.; the oiling devices mentioned will also be recognized as essentially "Straight Line." The eccentric rod, so called, although there is no eccentric, has ball and socket bearings at each end, the balls being case-hardened and ground, and the sockets or boxes of phosphor bronze. The rocker arm, by which the eccentric rod drives the valve, is horizontal, with a vertical axis; there is no twisting strain on either of its bearings, a straight line passing through all three of them. An index finger attached to this arm, as shown in plan view, Fig. 3, shows, by the graduations over which it passes, the movement of the valve, and thus is of assistance in valve setting.

A small sight-feed oil cup, directly over the centre of the rocker arm, supplies oil through a tube to the outer end of the arm. The eccentric rod is hollow, being, in fact, a piece of hydraulic pipe, and through it the oil passes to the eccentric pin, any oil finally escaping being caught and held in the flanged fly-wheel.

The centre bearing of the rocker arm works in a bath of oil so arranged that it is constantly flooded, and so that no oil can escape to the floor, any overflow draining to the crosshead guide, and finally to the crank pit.

The crosshead is a single steel casting, of the "Slipper" type, the bottom of the slipper being babbitted. The piston rod is secured by being gripped in two places, about two inches apart, one place being threaded and the other a parallel fit. The crosshead is split and is gripped on to the rod by bolts; this proves very good, in that it can be taken apart and put together again without getting out of line more than permissable in the highest grade of engine work—a point in which the usual methods of securing piston rods to crossheads (with the exception of the taper fit and key) are often faulty. The crosshead pin is of cast iron, as it is believed that, in connection with the large and long bearing, it is the best material for the place. The connecting rod is a steel forging, the crank end being of the "Marine" type, while the crosshead end is mortised for boxes, which are cast iron, lined with babbitt. The adjustment is by a wedge and adjusting screws.

The babbitt used in the engine is made from eight parts Banca tin and one part each of antimony and copper. The piston is a single casting with sprung rings; it is made extremely light, both to save the cylinder from wear and to make it the "breaking-down piece;" though amply strong for all legitimate loads it is expected to be

weaker than other parts, the idea being that it is the best thing to break, when experiments to determine the compressibility of water are being made with it. The exhaust passages are jacketed by air spaces from the cylinder, and from the live steam in the steam chest. The throttle is a modification of the "Cotton Valve" used by the Straight Line Engine Co., but is operated by a lever instead of a wheel, or ball handles.

The workmanship is intended to be equal to that of any other engine built. The firm also build cheaper automatics, but this engine was brought out to till a demand for which they have previously been obliged to import the best and highest priced American engines. The engine was designed and its manufacture organized by Mr. E. J. Armstrong, who is now with the Ames Iron Works, Oswego, N Y, which company will also build the engine in this country.

A New Ventilating Fan.

At a meeting of the Lancashire Branch of the National Association of Colliery Managers, recently held at Wigan, Mr Wm Hopton, of St. Helens, brought before the meeting a plan of his new drum shaped air producing fan He said that the idea of an improved fan had been revolving in his mind many years, but he never contemplated that he would bring one out himself. In the early part of last year he drew a plar of a fan, but after repeated alterations and improvements, he had a wooden model made. Still he found that there could be no further improvement. He accordingly had a small fan made by Messrs. Daglish and Co., St. Helens, 4 ft. 6 in. by 3 ft., which gave great satisfaction in the quantity of air produced when tested. His fan is the shape of a drum, having eight blades or scoops. The air entered the fan on either one or both sides of its diameter, and discharged air all around its circumference. He wished them to understand that the fan caused streams of air to flow through it similar to a locomotive engine on the railway when it obtained water from a long trough in the centre of the road. Doubtless they had seen on the railway in the centre of the road a long trough of water about 200 yards in length. Now, when the engine ran along the line at a great speed, the water in the trough was scooped up into the tank, and as the speed of the engine increased the water rushed into the tank with a much greater force. So, in like manner, the air was scooped up into and through the fan by means of those eight blades which he had previously mentioned, and passed out of the fan all round its circumference, and as the velocity of the fan increased, the eight streams of air became stronger and stronger, till quite a hurricane of air was produced. "I believe," said Mr. Hopton, "that my fan will produce a greater quantity of air than any other, and with less horse-power too; because the fan is not heavy or ponderous. Only the shafts, blades, and arms revolve. It is not necessary that the blades should be made heavy and thick; boiler plates similar to other fans 40 ft and 45 ft. in diameter, ¼ in. thick plate, will be quite sufficient. Suppose a current of air is travelling at a velocity of 300 feet per minute through an aperture or open space of one foot square, 300 cubic feet of air per minute will pass through the aperture Agan, suppose the air is stagnant, motionless, and we are able to pass the aperture through the stagnant air at a velocity of 300 feet per minute, by the law of nature 300 cubic feet of air should pass through the aperture By this illustration you will better understand the quantity of air that will pass through one of my fans Suppose, then, that one of the fans is 24 ft. in diameter, and 9 ft. wide, its circumference will be 753·984 ft. Further, if the fan makes 100 revolutions per minute, its circumference will pass over a space of 75359·84 ft.; there are eight scoops in the fan, each one having an aperture near its circumference for air to pass through of 4 ft. wide by 9 ft. long, and, as there are eight such apertures, the total area is 288 ft. Multiply then 75359·844 by 288, and this will give you a grand total of 2,171,473 cubic feet of air. Gentlemen, I shall not attempt to make you believe my fan will produce over two million cubic feet of air per minute, for it would be impossible for the scoops of the fan to get hold of the air so quickly in its natural and dense state. The air would be much expanded or rarefied in passing so quickly through the fan; I therefore divide the quantity of air by four, yet I have over half-a-million cubic feet of air produced by the fan. Had I means at my disposal I would fix one at some colliery, and would guarantee that over half-a-million cubic feet of air would pass through it, or I would charge nothing for the fan. The two streams of air which passed through the diameter on both sides of the small fan when tested was too strong to be measured by the anemometer. It drew in the overcoat of an official of the firm, he having passed too near it. There is little weight or pressure of the air on the blades or scoops of the fan as it revolves. The air can slide freely, with little or no friction, through each aperture; not a weight of over two tons of air carried along with the blades, as some fans do, when revolving, before the air can escape therefrom A cylinder, 17 in. diameter, 18 in. stroke, and 55 lb. pressure of steam, would work the fan the number of revolutions required, and when fixed would last a lifetime. At the close of Mr Hopton's paper, a hearty vote of thanks was accorded to him, and it was decided to accept the invitation to St Helens on the 23rd inst, to visit the fan at work at Messrs. Daglish's establishment, and afterwards to hold a meeting in St Helens to consider the merits of the fan as exhibited.

Explosions, Gob Fires and Coal Dust.

At Longton, on the 22nd ult., Mr. Joseph Taylor delivered the twelfth of a series of mining lectures in connection with the Staffordshire County Council.

The chairman (Mr. Joel Settle, of the Madeley Coal and Iron Co.), confined his opening remarks chiefly to gob fires. With these he had had a great deal to do, in the most fiery seams and district in the country, and his remarks were on this account of special interest and value. Whenever any indications of a gob fire manifested themselves they must be attended to, as he never knew a case in which a gob fire was arrested or extinguished of itself. His experience taught him that the best plan, as a rule, was to build off the place threatened with a gob fire on the return side, as this would cause the carbonic acid gas to back upon the fire and so help to smother it.

Mr. Taylor commenced his lecture by stating that he would confine himself mainly to explosions and coal dust. He would comprehend his treatment under the following heads: (1.) Definition and condition of an explosion; (2) phenomena attending explosions; (3) afterdamp and other effects of explosions; (4) how explosions are caused; and (5) how they may be prevented. This would bring in the consideration of both gob fires and coal dust, and enable him to lay before them many important results of recent scientific investigations.

An explosion in a general sense observed the lecturer, might be defined as rapid oxidation; but this was not sufficiently specific for their present purpose. As miners they had to deal chiefly with explosions of firedamp, but there were sometimes boiler explosions; and, as he should show, explosions of coal dust even when there was no fire damp present to begin with. In dealing with the conditions of an explosion as commonly understood, Mr. Taylor explained that there must be present a certain amount of marsh gas, methyl hydride, or firedamp, CH_4; and this must be mixed with a certain amount of atmospheric air; the mixture giving the greatest heat and force, as well as the loudest report possible, being one part firedamp with nine and a-half parts of atmospheric air. The afterdamp produced by an explosion under these conditions was not composed exclusively of chokedamp, but of seventy-one parts nitrogen, twenty parts aqueous vapour, and nine parts only of chokedamp, or carbon dioxide, in every hundred. The relative proportion of these substances, however, was soon changed, owing to the condensation of the aqueous vapour on the comparatively cold surface of the roads. These points were illustrated by beautiful experiments, as also was the necessity for a definite mixture in order to give the maximum explosive force and temperature.

The temperature produced by an explosion occurring under the conditions supposed might be imagined, from the fact that 1 lb. of CH_4 burning to CO_2 and H_2O yields about 23,550 units of heat; which might be converted into units of work by multiplying by 772. In the experiment showing this rapid and considerable rise of temperature, the glass instrument used was smashed almost immediately after being lighted.

This rise of temperature causes a sudden expansion of the air and gases present; and the expansion is so great that 1 cubic foot of mixed firedamp and air on being exploded, becomes at the moment of explosion no less than 8 cubic feet. The lecturer enlarged on these facts as explaining the origin of the explosive wave, as well as the dire effects of explosion.

The force developed by an explosion under conditions of the maximum explosive mixture equals 13·8 atmospheres, or 30,000 lbs. per square foot, and exceeds that of the most disastrous hurricane. If, in case of a hurricane, the air travels at the rate, say, of 100 miles an hour, the pressure per square foot upon bodies with which it comes in contact is only about 50 lbs. per square foot; and though this is sufficient to tear up trees and blow down bridges and almost every kind of masonry we in England construct, it is as nothing when compared with the 30,000 lbs. per square foot obtained in a colliery explosion. Such facts as these would enable them to understand how it is that frequently explosions tear down the roof, displace the timber, break up strong iron plates, wheels and axles.

Those who, like himself, had personally witnessed explosions, knew that they were generally attended by several distinct shocks; and these, he considered, had not so far been sufficiently understood and explained by mining authorities. The first shock produced the most disastrous effects, and was felt all along the line of the explosive wave, and often to great distances from the seat of explosion. It was due principally to the force developed by the expansion of air and gases owing to the great increase of temperature. The second shock, which was sometimes almost equally disastrous, was generally due to the formation of a vacuum, partly in consequence of the rush forward, but chiefly as the result of condensation of volume. A mixture of one cubic foot of firedamp with nine cubic feet of air, making altogether ten cubic feet, would, after explosion, occupy only nine cubic feet, thus forming one foot of a vacuum. In case of mine explosions the vacuum thus produced was considerable, and the rush of air to fill this gap up immediately after the first shock, under the enormous weight of the atmosphere, was the chief cause and explanation of the second shock. A third shock was also frequently noticed, and this was shown to be due chiefly to the rebound of the air and gases owing to their great elasticity. Sometimes, also, explosions were of a compound and very complex character, owing to the escape of occluded gas from the coal sides into the vacuum, and also to the influence of the heat on the coal dust, producing firedamp sufficient to cause a repetition of the explosion, and sometimes more than one.

In dealing with the causes and prevention of explosions, it was impossible to avoid saying something respecting coal dust. In giving his evidence before the Royal Commission on Coal Dust, Mr. W. N. Atkinson, Her Majesty's inspector of mines, had regarded coal dust proper as that which was sufficiently fine to pass through the meshes of a standard wire gauze; and this Mr. Taylor considered the best definition of coal dust yet given. Such dust was not explosive of itself, in the same sense as gunpowder, as was proved experimentally; but if very dry and suspended in the air so as to be in a position to admit of the carbon being rapidly oxidised, it doubtless did become explosive. The function of coal dust in relation to the cause of explosions was a somewhat vexed question, and the lecturer was anxious not to be dogmatic; but he, personally, was decidedly of opinion that an explosion might take place in conjunction with a blown-out shot in case coal dust was suspended in the air in sufficient quantity, even if there were no firedamp present whatever to begin with. The explanation was easy enough. Coal dust, as was illustrated by diagrams showing its appearance under the microscope before and after explosion, was porous and contained a large amount of occluded gas. This was driven off by a flame from a blown-out shot. The dust was distilled, even as coal is in the process of gas manufacture. The firedamp thus produced at once explodes, and causing still further distillation of gas from the coal dust itself, may give rise to a series of explosions almost simultaneously, and propagate the disaster as far as the coal dust extends and is sufficiently dry. Thus, said Mr. Taylor, was one of the most recent and important results of scientific investigation. It might now be considered as almost beyond controversy, as an established fact; and hence he felt justified in introducing the question in the present course of technical lectures. The possibility of exploding coal dust was practically demonstrated by an experiment.

The subject of gob fires having been dealt with so ably by the chairman, the lecturer said he would confine his remarks to the much-controverted question as to the cause of gob fires. It had long been held that these spontaneous ignitions were due to the oxidation of iron pyrites present in the coal, but this theory always had to face very formidable difficulties. It was true that iron pyrites in sufficient quantity might be made to burst out into flame, but it very rarely happened that there was enough of this compound present in coal to cause spontaneous combustion, since those varieties most liable to and noted for self-ignition only contained about 0.8 per cent. As against the common theory, it was also a remarkable fact that gob fires frequently broke out in seams where scarcely any pyrites was present, and in some seams noted for its presence no gob fires had occurred. These facts and a number of others adverted to by the lecturer, especially the peculiar property of carbon for condensing and absorbing gases on its surface, led the theory in question long since to be suspected, and now we are in a position to announce that without question gob fires really result not from the oxidation of iron pyrites, but from the heat developed during the oxidation of the coal itself. Temperature, dryness, capacity for absorbing moisture, and fineness of the particles, were also shown to be very important factors. When the gob began to give off smoke and "stink," and the temperature became sensible, especially when the thermometer indicated 90 degs., it was time to make a move, and then the air supply must by some means at once be shut off so as to prevent further oxidation. Whether the stopping should be built on the intake or return side of where the fire was threatened was a matter which could only be determined by special circumstances, and no universal law could be laid down. No theory would fit all possible occasions, and much depended upon intelligence, practical experience and careful technical education.

The Prevention of Winding Accidents. — A new apparatus for the prevention of winding and over-winding accidents at collieries and blast furnaces, is described by Mr. W. Grimmit, in the *Transactions* of the Federated Institution of Mining Engineers, vol. ii., page 243. Two cylinders partly filled with liquid are connected by a pipe at their lower ends. In this pipe is a valve for regulating the speed of flow from one cylinder to the other, and the pipe is also passed through five or seven small cylinders in which loose plugs can rise and fall. When these plugs come opposite the tube, they obstruct the passage of liquid from one main cylinder to the other. Plungers in these two main cylinders are connected by a rope over a drum, driven to correspond with the main winding drum, so that their position indicates the whereabouts of the cages in the shaft. If from any cause the speed becomes too great, the liquid cannot, owing to the regulating valve in the pipe connecting the cylinder, maintain a constant level. Accordingly a float in an indicating cylinder connected to the main cylinder, falls, and, through tripping mechanism, closes the steam valve and puts on the brake—the latter operation being performed gradually owing to the interposition of a pneumatic cylinder. The ordinary speed of winding is controlled by the regulating valve, but the speed may also be controlled at or from any suitable point by means of the plugs above referred to. One or two may be connected to the indicating gear, so as to obstruct the passage of fluid, and thereby stop or slow down the engine at any desired point. The other plugs can be used for stopping the cages at intermediate insets in the shafts, and one plug may be connected to a wire in the shaft used for signalling purposes.

LEGAL.

WILLS vs. STEWART.

Side Lights on the General Phosphate Corporation.—Broker Sando's Fat Commissions.—Interesting Facts of the Defunct Phosphate Boom.—Boodle Galore.

The suit of J. Lainson Wills, F.C.S., late manager to the General Phosphate Corporation, against George Stewart, vendor of the High Falls phosphate properties to the General Phosphate Corporation, and until recently its mining contractor, claiming commissions outstanding on the sale of the property, comes off at Aylmer on 17th instant. Interesting revelations of the inception, organization, management, and subsequent failure of the Corporation are promised. In the meantime, knowing the interest that is taken in the event, we have taken special pains to get at some of the facts, which we present herewith. J. Lainson Wills came to Canada in June, 1888, under a two years' engagement as manager with the Canadian Phosphate Company, Limited, of London, operating certain phosphate mines on the Lievres River. This engagement terminated after the completion of the first year, and from June, 1889, he resided in Buckingham, where he carried on practice as a consulting mining engineer. Among local properties reported upon by Wills about this period may be mentioned:

(1) The Glasgow-Canadian Phosphate Company's mines in the Townships of Portland and Derry.

(2) The Squaw Hill and Aetna mines, now operated by the Anglo-Continental Guano Works Co., of London, England.

(3) The Little Rapids mine and other properties owned by W. A. Allan.

(4) The Central Lake mines, owned by S. P. Franchôt and others.

(5) The Blackburn mine in Templeton, now owned by the East Templeton District Phosphate Syndicate.

(6) The McMillan mine, owned by the Dominion Phosphate Company, of London, England.

(7) The North Star mine, owned by the Dominion Phosphate and Mining Company, of New York.

(8) The Murphy mine, Templeton, property of Sir J. J. C. Abbott and Hon. C. C. Colby, since acquired by the Corporation.

(9) All the Stewart phosphate lots in the Township of Bowman (amongst which are the High Falls group, sold to the Corporation), the whole containing 1450 acres.

The last named is the object of the present reclamation. The properties were reported on by Wills on 30th July, 1889, and the original report with maps, etc., handed to Stewart, for which Wills received the sum of one hundred dollars.

In November, 1889, Stewart, in company with E. B. Haycock, of Ottawa, sailed for London with the object of finding a buyer for the phosphate properties above mentioned. About this time the "boom" took place, and several important sales of Canadian phosphate mines were made, notably the Blackburn, the Squaw Hill and Aetna, the McMillan, and others. With the object of assisting Stewart in his negotiations, Wills sailed for England in January, 1890. He avers that Stewart had personal interviews with him daily, and that he (Stewart) was depending on his information and advice to obtain purchasers for his properties. Wills, however, had not so far received a cent from Stewart outside of the fee of $100 for his report.

STEWART'S AGREEMENT WITH WILLS.

Wills contends that the arrangement for recompense was based on Stewart's letter to him, dated London, 20th February, 1890, as follows:

"In consideration of your services rendered, and now rendering, in connection with the sale of the following phosphate lands, in which I am interested, that is to say:

The Bowman group and Poupore, 400 acres.
High Falls group, 1,450 acres.
Ray and Cowan group, 400 acres.
McKenzie group, 200 acres.
Chapleau group, 700 acres.
Allan group, 1,000 acres.
J. W. McLaren group, 216 acres.
McCallum group, 400 acres.

On a sale being effected of the part or whole foregoing properties through the aid of your aforesaid professional services, I agree to pay 2½% of the cash sale obtained.

Very truly yours,
(Signed), GEO. STEWART."

The Stewart properties were acquired by the General Phosphate Corporation, Limited, of London, for a consideration of forty thousand pounds sterling, Wills being present with Stewart in the offices of the Corporation at the time of the drawing up of an agreement dated at London, 30th September, 1891, by which the sale was determined. It was thus taken for granted by Wills that the commission of 2½% on the £40,000, namely, £1,000, (or $4,866.69) was justly earned, it being only a question of Stewart having the funds in order to obtain a settlement. Wills avers that it was only after presenting his statement of current accounts to Stewart in September, 1891, that Stewart's objection was made to the payment of this commission.

STEWART'S DEED OF SALE TO THE CORPORATION.

An agreement made the third day of September, one thousand eight hundred and ninety, between George Stewart, of 128 Lyon Street, Ottawa, in the Dominion of Canada (hereinafter called the Vendor) of the one part, and the General Phosphate Corporation, limited (hereinafter called the Corporation) of the other part. Whereas, the Vendor is entitled for an absolute estate in possession, free from encumbrances, to the several phosphate properties and rights hereinafter described, and he has procured from the persons whose names are set forth in the second schedule hereto, the reports and analysis in the said schedule mentioned with regard to the character of the said properties and the nature and quality of the phosphate produced therefrom. And whereas the Vendor has furnished the Corporation with a statement in writing, which he has represented to be an accurate epitome of the said reports and analysis, and to be an exact description of the said properties; and the said statement, as also the said reports and analysis, have, for the purpose of identification, been signed by the Vendor and Lydstone Joseph Langmead on behalf of the Corporation. And whereas the Vendor is desirous of selling the said properties to the Corporation, and the Corporation is willing to purchase the same upon the terms hereinafter mentioned, but subject to the power of rescission hereinafter contained. Now it is hereby agreed as follows:—

The Vendor shall sell and the Corporation shall purchase, all those pieces or plots of freehold land situated on the River Lievre, twenty-one miles from Buckingham, in the County of Ottawa, in the Province of Quebec, and Dominion of Canada, amounting in the aggregate to one thousand four hundred and fifty acres, and known as the High Falls group of phosphate properties, and (the several lots of which are more particularly described in the first schedule hereto) together with the mines and mining and other rights, and the plant, machinery, stock and other property which are now on the said properties or belong to the Vendor in connection therewith, all of which land and premises are hereinafter called the scheduled premises.

2. The Vendor shall, immediately on the execution of these presents, hand over to the Corporation the original reports and analysis referred to in the second schedule hereto, and he shall, if so required by the Corporation, execute a statutory declaration that the said reports and analysis were in fact made by the respective persons by whom they purport to have been made.

3. The Corporation shall, with all reasonable despatch after delivery of the said reports and analysis, direct George Attwood, of Lombard Street, in the city of London, or some other competent person (to be approved by the Vendor) to proceed to the scheduled premises and personally test the accuracy of the said reports and analysis, and report to the Corporation upon the extent, nature, prospects, convenience and general desirability of the scheduled premises, and unless the report of such person shall confirm in every essential respect the said statement of the Vendor, the Corporation shall be at liberty, by notice in writing, served upon the Vendor on or before the thirty-first day of December, one thousand eight hundred and ninety, to rescind this agreement.

4. The Vendor shall warrant the accuracy of the statements contained in the said statement in writing, furnished by him to the Corporation as above recited, and the Corporation, if it does not avail itself of the right of rescission conferred by the last preceding clause, shall be entitled to recover from the Vendor, and he shall be liable to make compensation to the Corporation for, any loss arising from any misstatement of fact in the said statement.

5. The Vendor shall make out, to the satisfaction of the Corporation, a good title to the scheduled premises for an absolute estate in possession, according to the laws in force in the said Province of Quebec, free from all encumbrances.

THE PURCHASE CONSIDERATION.

6. The consideration for the said sale shall be the sum of forty thousand pounds, whereof ten thousand pounds part thereof shall be paid in cash on notification being made to the corporation, as hereinafter provided, that the transfer of the scheduled premises has been completed and the residue of thirty thousand pounds shall, but subject to the proviso for reduction hereinafter contained, with interest in the meantime at the rate of six per cent. per annum from the date of completion, be paid on the thirty-first day of October, one thousand eight hundred and ninety-five. The payments of the said sum of thirty thousand pounds, reducible as hereinafter mentioned, shall be secured by the covenant or covenants of the Corporation to pay the said sum, or the reduced sum, on the said thirty-first day of October, one thousand eight hundred and ninety-five, and the Corporation will also execute, in favor of the Vendor, an instrument of charge over the scheduled premises, for further securing the said thirty thousand pounds, or reduced amount, which instrument shall, however, contain provisions reserving to the Corporation the fullest power of carrying on business upon the scheduled premises, without notice to, or the consent of, the vendor, and reserving, also without such notice or consent, power to lease the property comprised in the said charge, as it may deem expedient, provided that the rent or other benefit reserved by, or payable under, any such lease, shall be subject to the said charge, and the said instrument shall further contain a provision that the said debt and the security therefor shall not, nor shall either of them, as to ten thousand pounds, part thereof, be assignable by the vendor for any cause whatever, without the consent of the Corporation being first obtained for that purpose.

7. The Corporation shall appoint some person in Canada to be its attorney or agent, with full powers in relation to the completion of the sale of the scheduled premises, and shall notify such appointment to the vendor not less than twenty-one days before the time hereinafter fixed for completion.

8. The sale shall be completed in Ottawa, in the said Dominion of Canada, on or before the thirty-first day of October, one thousand eight hundred and ninety, when the vendor shall duly transfer the scheduled premises to the Corporation or its nominees. The Corporation shall, at the time of such transfer, pay to the vendor, or as he shall direct, the said sum of ten thousand pounds, and will, within thirty days thereafter, execute, in favor of the vendor, the covenant and deed of charge referred to in clause 6 hereof.

£15,000 FOR PLANT AND A GUARANTEED OUTPUT.

9. Possession of the scheduled premises shall be given to the Corporation at the time hereby fixed for completion and the vendor shall thereupon proceed to provide and set up on the scheduled premises machinery, plant and appliances suitable for working and getting the phosphate of lime on the said premises. The said works shall be executed by the Vendor, under the direction and to the satisfaction of J. Lainson Wills, M.E., of Buckingham, Ottawa, aforesaid, or other the engineer for the time being of the Corporation, to be approved by the Vendor, and shall be completed within six months from the date of possession being taken by the Corporation. The Vendor guarantees that the sum of fifteen thousand pounds shall be sufficient to complete the said works and leave a sum sufficient for working capital to be employed in carrying on the scheduled premises and the Corporation hereby agree to expend and employ that sum or such less sum as may be required for these purposes and will immediately after completion of the purchase pay to the Vendor an instalment of two thousand pounds for the purchase of the necessary plant machinery, or such other sum as the said engineer may certify to be required for the purpose, and upon production of the certificate of the said engineer that work of that value has been executed to his satisfaction by the Vendor, such further portion or portions of the said sum of fifteen thousand pounds as may be applicable and necessary from time to time to be certified by the said engineer to the completion of the said works. The Vendor will, for a period of twelve calendar months at least after a commencement shall be made to work the phosphate on the scheduled premises, devote his whole time and attention to the working and development

AT A SALARY OF ONE THOUSAND POUNDS

for that period, and will, under the direction aforesaid, carry on the operations thereat; and the Vendor hereby guarantees that during the said first twelve calendar months after the fixing of the said plant and machinery and the commencement of operations for working the phosphate on the scheduled premises with the use of plant and machinery erected by the Vendor as aforesaid and the residue of the said sum of fifteen thousand pounds being employed as working capital, an output of not less than ten thousand tons of phosphate ore, containing not less than seventy-five per cent. of phosphate upon an average, so that no ore containing less than seventy per cent. is shipped, will in the ordinary course of working be yielded and will be put free on the wharf at Montreal at a total cost to the Corporation for mining and transport of not more than nine dollars per ton, and the vendor hereby agrees that if the said guarantee is not performed, the Corporation will, out of the thirty thousand pounds secured to the Vendor by the instrument mentioned in clause 6 hereof, be entitled to retain absolutely for its own use the sum of ten thousand pounds, and the said instrument of charge shall contain a proviso restricting the indebtedness of the Corporation thereunder and reducing the charge on the said scheduled premises by a sum of ten thousand pounds with all interest thereon in the event of the Vendor failing to implement and perform the guarantee hereinbefore expressed and contained.

10. The Corporation shall provide the Vendor with the necessary funds to pay mining and transport at the rate of not exceeding nine dollars per ton, but the Corporation are under no obligation to find any further moneys until the said fifteen thousand pounds shall have been exhausted, and then only such sums as shall represent nine dollars per ton in respect of ore delivered at the wharf at Montreal and certified by the engineer.

11. The Vendor and the Corporation shall pay their respective costs of, and incidental to the preparation and execution of this Agreement and of the transfer of the scheduled premises to the Corporation, and if the result of the inspection and report to be made pursuant to clause 3 hereof, shall be deemed unsatisfactory, by the Corporation, or if the Vendor shall fail to show a good title as aforesaid to the scheduled premises, the Vendors shall pay all costs, charges and expenses incurred by the Corporation in relation to such inspection and report, but so that such last mentioned costs, charges and expenses, shall not exceed the sum of seventy-five pounds.

12. For the purpose of this Agreement any notice may be given to the Vendor by leaving the same for him at the Bank of Ottawa, in the city of Ottawa, in the Dominion of Canada, or (at the option of the Corporation), by leaving the same for him at the office of Messrs. Harper & Battenck, Solicitors, 23 Rood Lane, in the city of London, and any notice so left shall be deemed to have

reached the Vendor within fourteen days after its being so left.

13. If, and so often as any difference shall arise between the Vendor and the Corporation as to the meaning or construction, or the effect, incidence or consequence of this Agreement or any part thereof, or any article or clause herein contained, or otherwise relating to the premises: every such difference shall be referred to the arbitration of two Arbitrators, one to be appointed by each party, with liberty to them to appoint an umpire or third arbitrator, and this submission shall be subject to the provisions of the Arbitration Act, 1889, or any subsisting statutory modification thereof.

In witness whereof the said George Stewart has set his hand, and Sir Jacob Wilson, the Hon. Cecil Parker and H. Mallaby Deeley have set their hands on behalf of the General Phosphate Corporation, Limited, the day and year first above written.

THE FIRST SCHEDULE ABOVE REFERRED TO.

Description of the lots of the property agreed to be sold:—

Lot 6 in the 10th Range of the Township of Portland West.

Lots 1, 2, 3, 4, 5 and 6 in the 4th Range, Bowman.
Lots 17, 18, 32 and 33 " 3rd " "
Lots 31 and 32 " 2nd " "
—1450 acres.

THE SECOND SCHEDULE ABOVE REFERRED TO.

Report dated 30th July, 1889, made by J. Lainson Wills, F.C.S. and M.M.S., of Buckingham, late manager of the Canadian Phosphate Company, Limited

Report dated 12th June, 1889, made by Robert Bell, B.A., M.D., LL.D., F.C.S. and F.R.S.C., Royal Commissioner on the Mineral Resources of Ontario.

Analysis dated the 2nd January, 1890, by George Patterson, F.I.S., F.C.S., of Idol Lane, in the city of London.

Witness to the signature of George Stewart, the said George Stewart.

J. H. DAVIDSON,
40 and 42 Queen Victoria street, London,
Solicitor.

For and on behalf of the General Phosphate Corporation, Limited—

JACOB WILSON,
CECIL T. PARKER,
H. MALLABY DEELY } Directors.

LYDSTONE J. LANGMEAD,
Secretary.

We have examined the above with the original agreement, and certify it to be a true copy thereof.

DATED, this 10th day of September, 1890.

WALTER HARRIS,
J. HENRY GERMAN,

Clerks to Messrs. Davidson & Morriss,
20 and 42 Queen Victoria St. London, E.C.,
Solicitors.

STEWART'S AND SANDO'S SHARE OF THE SPOILS.

In an interview with the plaintiff, we learned the following particulars of this now historic transaction. Stewart sold to the Corporation for £40,000 sterling at the time of the transfer of his properties. A mortgage to the amount of £20,000 sterling was negotiated by Mr. Knud Sando, a London Broker, now posing as one of its directors, which realized, according to a statement made by Sando, £18,600. Sando retained £11,000 as his commission. Stewart therefore asserts that he has so far received only £17,600 for his phosphate properties sold to the Corporation. By the agreement made between Stewart and the General Phosphate Corporation on the 9th September, 1890, Stewart was to leave £10,000 in the hands of the Corporation as a pledge and guarantee for the fulfilment of his contract. Wills also states that in a personal interview with Stewart at Buckingham on 28th September, 1891, the latter showed him a typewritten statement and cash balance, which he stated was rendered by Sando for his negotiation of the £20,000. The figures quoted, he states, are taken from this account.

THE OTHER SIDE OF THE CASE.

Mr. Stewart, on the other hand, states that after the signing and delivering of the letter in Wills' declaration, the Plaintiff wholly failed to sell the property, and that afterwards, about the end of August, 1890, Plaintiff entered into the employ, and became the agent and servant of "The General Phosphate Corporation, Limited," that thereupon the engagement and proposed engagement between Plaintiff and Defendant referred to in said letter ceased, that Plaintiff did not thereafter take part in the sale of the property referred to in said letter as the agent, servant, or broker of Defendant, and that Plaintiff never thereafter assisted in the sale of said property, and Plaintiff never assisted Defendant in disposing of said property and that Defendant never sold said property through the aid of any professional or other services rendered Defendant by Plaintiff.

That after Defendant had entered into the employ of the said General Phosphate Corporation, Wills was sent to Canada by said Corporation to report on the said property referred to in said letter, along with other property, and that any report or statement Willls made in connection with said property was made in his capacity of agent, servant and engineer of said Corporation, and was not made in virtue of the arrangement referred to in said letter and in Wills' declaration, and that Stewart never was, and is not bound or obliged to pay any commission therefor, or any consideration whatsoever there for.

That on or about the 5th day of November, 1890, Stewart sold the property referred to, along with other mineral property, to "The General Phosphate Corporation, Limited," aforesaid, and that if Wills' services or his report in any way contributed to the sale thereof, which is not admitted, but especially denied, such services were rendered and such report was made to said Corporation, by the engineer and servant of such Corporation, and not by reason of said letter, or by reason of any engagement with Defendant.

That the sums of money paid by Stewart to Wills and referred to in his declaration were paid to assist Wills and because he had been of some service to to Defendant in various ways, but the same were not paid because Defendant was legally bound and obliged to pay the same, and in any case the amount was more than sufficient to pay Wills for any services rendered.

Stewart further declares that he only derived from the sale of the property to the Corporation, after all commissions had been deducted and paid, about £16,000. Of this he received £10,000 in cash, and that his securities, which represented the balance, after commissions for the same were deducted, only brought him £6,000. Stewart states that the others who owned an interest in the High Falls property were Newell Bate, of Ottawa, and Thos. Bate, of St. Catherines. Other parties are also claiming commissions from Stewart for the sale of the property, or for the negotiation of his securities. Among them Knud Sando, Broker, London, England; Hawkins & Co., London, England; Kimberly & Co., London, and J. A. McIntosh, of Toronto. Stewart states that he has already paid Wills $2,141.30 for the services sued for, and that this amount is more than sufficient to cover his claim.

EXTRACTS FROM WILLS' DEPOSITION.

Q. Didn't Mr. Sando have something to do with the sale? A. Probably he completed it.

Q. You know Mr. Sando? A. Yes: he is a broker.

Q. Did you know that Mr. Stewart had dealings with him in connection with the sale of the property referred to in Exhibit No. 1? A. No.

Q. You did not see them together in London? A. He had dealings through a broker—through an intermediary: I do not know that he had dealings with Mr. Sando. He would have dealings indirectly with him through brokers with whom I was in contact. There comes the pull.

Q. Didn't you see Mr. Sando working for Mr. Stewart at this time? A. No. Mr. Sando asked me in the most direct manner for my appreciation of Mr. Stewart's properties.

Q. When did he ask you? A. Immediately on my arrival in London.

Q. In what month? A. In January, 1890.

Q. He was interesting himself, then, at that time, about the sale of these properties? A. No.

Q. Do you swear he was not? A. It was more as a purchaser.

Q. He was interesting himself about the sale, was he not? A. As a purchaser.

Q. If he was a broker, he would not likely purchase them himself? A. He would not sell them unless he had a bond on them himself.

Q. Do you know he had a bond for the sale of this property from Mr. Stewart at the figure of £29,000. A. At the time he could not have.

Q. Do you know that he afterwards had? A. I do not know that he had.

Q. Do you swear positively that he had not? A. I can swear I do not know when Mr. Sando obtained a bond on Mr. Stewart's property.

Q. Do you swear that you do not know anything of such a bond? A. I know that the sale was afterwards completed.

Q. By whom? A. By the Corporation.

Q. Through whom? A. That I do not know.

Q. Don't you know that Mr. Sando conducted negotiations that led up to the sale to the Corporation in your absence? A. I do know that.

Q. When? A. Since my return. It was during my absence from London that was completed.

Q. Mr. Sando then had charge of the negotiations to a certain extent which led up to the signing of the document of which it is claimed Exhibit "A 1" is a copy. A. I surmise so.

Q. You were not in London at the time the basis of this arrangement was arrived at, Exhibit "A 1?" A. Yes.

Q. I thought you had left London? A. I have told you already that I returned in July. This was drafted one or two days before it was signed.

Q. You knew that Mr. Sando at the time was looking after the interests of Mr. Stewart, and trying to sell the property for him? A. That I do not know.

Q. You do not? A. No. I recognized Mr. Sando at that time. I am talking of that time. What month are you talking of?

Q. I am speaking of September, 1890. You recognized Mr. Sando at that time? A. In what way?

Q. I am asking you in what way. You said you recognized him didn't you? A. Doing what?

Q. Bringing about these sales. A. Mr. Sando was taking a prominent part as a promoter in September, 1890.

Q. He was promoting for the purpose of getting the Corporation that was being formed, or that had been formed, and that he was instrumental in forming to purchase this property? A. Yes. He would have obtained a bond, and was endeavouring to sell to the General Phosphate Corporation through brokers.

Q. Don't you know that the figure was mentioned in that bond of £29,000? A. No; I did not know it at that time.

Q. You have known it since? A. Yes.

Q. And you have seen sufficient and know sufficient to enable you to say that you have no doubt that Mr. Stewart had then given a bond of sale on his property for £29,000? A. I do not know that.

Q. Did you not say that just now? A. I made a mistake if I said it.

Q. Who told you of this bond that you have spoken of? A. I should know that Mr. Sando could not well offer the property at that time without having some hold on it. At least I should surmise.

* * * * * *

Q. When did you first hear of the £29,000 being the price mentioned in the bond? A. It would be after the time of the misunderstanding between Mr. Stewart and myself with regard to the commission I am claiming When he showed me a document purporting to be an account current between Mr. Sando and himself which exhibited the same amount that he stated to-day. That is the first time I knew of the price of any commission that Mr. Sando was getting.

Q. When was that? A. In Buckingham, after the sending of my account in to him; some time away into the summer. I could not say exactly.

Q. That was about what year? A. Last year; 1891. the summer of 1891.

Q. You went home to England lately, did you not? A. Yes.

Q. Did you learn there that Mr. Sando had received the commission from Mr. Stewart. A. Yes; generally I think I did.

Q. Did you not learn it there? No; I did not learn it there. I learned it first from Mr. Stewart in 1891.

Q. When you got back to England you realized that what Mr. Stewart had told you was true? A. Mr. Sando told me, I think. I think that is the only information I got on the other side.

Q. Are you in the employ of the General Phosphate Company at present? A. I am not.

Q. Are you aware that the 10,000 tons of phosphate that were to be delivered by Mr. Stewart in conformity with that contract under a forfeiture of £10,000 has not been delivered? A. I am aware it has not been delivered.

Q. You are aware that Mr. Stewart was in a position that it was impossible to deliver it from these mines within the time specified in the contract? A. No.

Q. Were you not engineer for the General Phosphate Corporation? A. Yes.

Q. You know that it was not done? A. I know that it was not done.

Q. And you know that it was not through the fault of Mr. Stewart that it was not done? A. Yes, it was through his fault.

Q. You swear that? A. Yes; it depended on Mr. Stewart entirely.

Q. You did not assume any responsibility at all? A. No; not as engineer of the Company.

Q. All the works were carried on under your management? A. I'o; they were not.

Q. What were you there for? A. To control.

Q. To control Mr Stewart? A. To control the putting up of machinery and Mr. Stewart's accounts.

Q. Do you think that Mr. Stewart would wilfully incur that forfeiture of £10,000? A. I do not know. I can not account for Mr. Stewart's actions.

Q. He is a strange man in your estimation? A. I do not know. I do not say so.

Q. I suppose you thought he was a strange man when he signed this letter, Exhibit No. 1 A? A. I think he is a strange man when he does not fulfil the terms of it.

Q. You did not think he was a strange man when he signed it? A. I had not much experience of him then.

Q. You had a quarrel with Mr. Stewart lately? A. No, nothing more than difference of settlement of affairs, which had been the basis of Mr. Stewart's proposed sale.

Q. The General Phosphate Corporation consulted you? A. Yes.

Q. Did they pay you for it? A. not then.

Q. Did they pay you afterwards for those consultations? A. Yes, they paid me a fee of £100 or guineas, I forget which now, to control George Attwood's report.

Q. What was George Attwood's report? A. On other properties which they were acquiring together with Mr. Stewart's.

Q Did George Attwood's report refer in any way to the properties referred to in exhibit No. 1? A. No.

Q. Did you ever make any report to the General Phosphate Corporation in connection with this property? A. Not to the General Phosphate Co.

Q. You swear that positively? A. To George Stewart.

Q. You swear that you did not make any report and they have got no report that you made to them in connection with the properties referred to in exhibit No. 1? A. I have to understand this question before I can answer it.

Q. You swear that you did not make any report and they have got no report that you made to them in connection with the properties referred to in exhibit No. 1? A.

I have made no report to the General Phosphate Corporation as far as I can recognize any of these properties. It is very probable that they may be in possession of several reports which I have made for other people. They all gravitated to the General Phosphate Corporation.

Do you swear positively that you did not make a report direct to the General Phosphate Corporation of any of the properties referred to in exhibit No. 1, previous to the sale thereof.

Objected to as illegal and irrevelant.

Objection reserved.

A. I have not reported on any of these properties to the best of my knowledge that I recognize here to the General Phosphate Corporation.

Q. Did you report to the promoters of the General Phosphate Corporation before its actual incorporation in connection with any of the properties referred to in exhibit No. 1? A. Who are the promoters?

Q. I am asking you, you know more about them than I do? A. I do not know.

Q. Have you got any idea who would be the parties interested in the General Phosphate Corporation, and who were the parties interested in it in September and November, 1890. A. Yes.

Q. Who were they? A. The directors.

Q. Who were they? A. Sir George Baden Powell, Mallaby Deely, Lord Stalbridge, Sir Jacob Wilson and Cecil Parker.

Q. Did you make a report to any of these parties that you have mentioned in connection with the properties that are referred to in exhibit No. 1? A. No, positively not.

Q. Did you not see Mr. Sando engaging himself on behalf of Mr. Stewart from the time you returned to London in July, 1890, until the signing of exhibit "A 1" or the original agreement of which it is claimed that exhibit "A 1" is a copy? A. Yes, I saw him.

Q. You saw him doing what? A. I saw him. I met him and heard from him that the business was going on—proceeding.

Q. You knew then that he was taking up the matter for Mr. Stewart? A. Not more than he was continuing to consult me also as well as Mr. Stewart.

Q. It is not customary for a man in Mr. Sando's position to do such things I suppose after he had been engaged by Mr. Stewart to do so? Do brokers work for nothing in London? A. I cannot say.

* * * * * *

Q. Do you know if they paid cash to Colby, Abbott and Fleming, or if they owe them a considerable sum of money? A. They paid some cash.

A. And gave them mortgages on the property for the remainder? A. I do not know that. I know that the sellers had negotiable papers besides cash.

Q. You know that the outstanding liabilities of this General Phosphate Corporation are very large? A. I have no reason to know it.

Q. Don't you know that they owe a lot of money? A. I have no reason to knew it.

Q. Do you know it? A. You must remember that I gave in my resignation a month ago, and that they may have paid it all off since then.

Q. But a month ago? A. I have no idea.

Q. Can you give us no idea at all? A. No; not since last November.

Q. During last November how much did they owe? A. Stating from memory, we might have had a liability of eighteen or twenty thousand dollars.

Q. Would that be apart from the balance of the purchase money of these properties? A. I am speaking now when I say eighteen or twenty thousand dollars, of the money owing in Canada to merchants and for wages, etc.

Q. Apart from that, don't you know that it is largely indebted for the price of the property? A. That I don't know more than having a glance over the annual balance sheet. I know there is an indebtedness.

Q. A large indebtedness, too, for the price of the property they have bought? A. The largeness is comparative.

Q. Didn't this indebtedness in November for the price of the properties amount to somewhere in the neighbourhood of £40,000 sterling, or £50,000? A. I do not remember that it was as much as that.

Q. It was somewhere in that neighbourhood all told on all the properties? A. I do not know.

Q. I suppose the solvency of this Corporation depends altogether on whether this mining property turns out well or not? A. Yes; it depends on who works it.

Q. I suppose it depends also upon the quantity of phosphate that is to be found? A. Yes.

Q. So that if the phosphate trade does not turn out pretty well on these lots there is nothing for this Company to do only to go into insolvency—the usual fate of such Corporations? A. I suppose they fail—the natural consequence.

Q. A mortgage or hypothec given by such a Corporation would depend altogether upon the value of its mineral lands whether it was worth anything or not? A. To a large extent I should say it would.

Q. If those mineral lands were not worth the amount in the mortgages for which they were given as security, the vendor would virtually have no personal recourse against the Corporation that would be worth anything? A. I should say it would not apply to these properties. These properties are sufficiently rich in mineral wealth, but speaking generally I suppose it is so.

Q. I am asking you if these properties should not turn out to be very remunerative, is it not a fact that the vendor would have no recourse against the Corporation as a Corporation that would be worth anything? A. Probably so.

Q. Do you think that Mr. Stewart, if he had remained at home, and not gone to London, and had not employed people to assist him in the sale of this property, that he could have sold the property here for £18,600 that he has stated he received for it in cash as the net proceeds of the sale to the General Phosphate Corporation? A. It is ridiculous for me to give you any appreciation of that. *If I had not gone across to the other side I do not think* he could have made any sale at all.

Q. You do not think that he could have sold this property for £18,600? A. He would never have made a sale at all if I had not gone across to the other side.

Q. You said a little while ago that the sale was completed when you got there? A. I do not know.

Q. Didn't you say a little while ago that the terms of the sale to the General Phosphate Corporation had been *virtually completed when you got to London in August*, 1890? A. Yes; but I was in London before that period. I have been over five or six times now.

Q. Do you think that if those properties were put upon the market to-day and brought to sale in Canada—the properties that are referred to in Exhibit No. 1—that they would realize more than £18,600 in the condition they were in on the third of September, 1890? (Objected to as illegal and irrelevant, being completely foreign to the matter at issue in this case. Objection reserved). A. It is completely problematical.

Q. Well answer it? A. I do answer it: it is completely problematical.

Q. You are unable to say whether they would or not? A. If it was put into my hands for instance.

Q. Or if it was brought to sale by the sheriff to-morrow or a month hence do you think it would realize more than £18,600?

Objected to as above.

A. Not by sheriff's sale, that would depreciate it.

Q. But by private sale: if it was offered for sale at public auction do you think it would bring anything more in your opinion? A. It would depend on whose reports were backing it up and what brokers were handling it. It would depend upon the market price.

Q. Has not the phosphate industry greatly depreciated in the last couple of years? A. It may be up again next week.

Objected to as irrelevant.

Q. Has not the market value of phosphate lands greatly depreciated within the last couple of years? A. The market price of phosphate lands is always more or less fluctuating.

Q. At the present time the prices are down? A. Yes.

Q. And they have been down for a year or so? A. Yes; and may recover themselves to-morrow.

Q. In the present state of the market do you think these properties *if offered for sale at public auction* in the condition they were in in September, 1890, would bring £18,600?

Objected to as irrelevant.

A. Yes, I do.

Q. Would they bring more? A. Yes.

Q. You swear you think that? A. Yes, I think that.

Q. That is before any improvements were made upon them apart from the improvements that were on them in *September, 1890*? A. Yes. *There were very few improvements made on them from the terrible way they had been worked.*

Q. Had you an office in London during January, February and March, 1890? A. I had the accommodation of an office with my name on the door. Yes, I had an office in London.

Q. You had it in connection with somebody else? A. No.

Q. You were doing nothing else besides being in the interests of Mr. Stewart at that time? A. Yes, I was acting as independent mining engineer.

Q. Your services at that time were not exclusively given to Mr. Stewart? A. No, not exclusively, although my work at that time in London was limited to Canadian phosphate business.

Q. You did not limit your business by any means to the properties referred to in exhibit "A 1" during that period? A. No; there were others besides the High Falls property of Mr. Stewart. I could not sell them all.

CROSS-EXAMINED.

Q. What do you mean when you say that your occupation there was not exclusively limited to obtaining sale of Mr. Stewart's properties? A. There were other Canadian properties which were required to combine with Mr. Stewart's to make one successful undertaking—to wit Mr. Colby's which were acquired.

Q. Did you do there other work outside of the work which you were undertaking for Mr. Stewart, and if so, what was that work? A. It was the same kind of work, that is to say, the same brokers.

Q. And had you any other work? A. No other work except the specialty of Canadian phosphate properties.

Q. Your profession requires a special education? A. Yes.

Are there many mining engineers in Canada that are known in London? A. Yes: a great many but not Canadian.

Objected to as not arising out of the examination in chief, and that Mr. Wills is not the proper person to testify to his own value.

Objection reserved.

Q. Are there many mining engineers in the vicinity of Buckingham who are known in London and have the confidence of the London mining public? A. Not many.

Q. You yourself lived in London for some length of time? A. Yes.

Q. What did you mean when you said in your examination in chief that you may have had a conversation with certain people, namely, Messrs. Franchot, Mackintosh and Benson, about the commission paid or to be paid to Mr. Sando by the defendant? A. I do not remember having had a conversation with either of these gentlemen on that subject.

Q. *Then what do you mean by saying that you might* have had? A. But meeting them and seeing them so often, it may have transpired, or they may have suggested or inquired, or we may have had some conversation upon the subject in that way. Under oath I cannot deny flatly that I have never spoken of the commission to Mr. Sando.

Q. What do you mean when you say that the essential work of forming the Corporation, that is the General Phosphate Corporation, was done before you left London in March, 1890? A. Mr. Sando, who had been the figure head in the proposed amalgamation of Canadian phosphate properties in London at the time—I am speaking now of January, 1890—was receiving offers of properties to the extent of some 3,000,000 acres. The scheme was then known as the Phosphate Trust, and on my arrival in London in January, which was about the 23rd, I think, up to the time of my quitting it for South America, the middle of March, I was in constant communication with Mr. Sando—more particularly advising the selection of certain Canadian properties.

Q. You said that indirectly you may have contributed to the forming of the General Phosphate Corporation. What do you mean by that? A. I mean that the first scheme proposed by Mr. Sando as the Phosphate Trust was completely irrealizable, and from my counsel and advice to Mr. Sando, his whole plans were changed from the Phosphate Trust to the formation of the General Phosphate Corporation.

Objected to as not arising out of examination in chief.

Q. What do you mean by irrealizable? A. The first scheme had been so adversely criticized by financial and mining people both in London and in Canada, and properties of comparatively no value unknown to Mr. Sando had been misrepresented to him as good, and so on—that is what I mean by irrealizable; that it had been crushed by public opinion.

Q. You say "irrealizable?" A. I say it was not to be realized.

Q. You have stated that the capital of mining corporations chiefly consists of mining lands. Do you mean to say that these corporations usually invest all their capital, and keep no reserve? A. A well organized and well managed company would certainly keep ample reserve.

SOME OF STEWART'S EVIDENCE.

Q. You have stated that Mr. Wills, the Plaintiff, was not present at the time that the agreement, Plaintiff's Exhibit "A 1," was drawn up, dated the 3rd September, 1890. Is it not a fact that Mr. Wills was in the same building, in the adjoining room, and that you went to him for advice at that time? A. I have no recollection of it.

Q. Will you swear that such is not the case? A. No; I will not.

Q. Was a draft of this agreement, Exhibit "A 1," made previous to the 3rd September, the date on which it was signed? A. Yes; there was.

Q. When was that draft made? A. I cannot recollect the date.

Q. Is it not a fact that Mr. Wills was present in the same building, in the adjoining room, when the draft last spoken of was prepared, and that you on that occasion consulted him? A. I do not think so.

Q. You will not swear that you did not? A. No.

Q. When did you pay Mr. Wills the $2,141 on account of commission due under this letter of the 20th February? A. In different payments.

Q. About what dates? A. Mr. Aylen has the account of that. I cannot recollect the dates.

Q. Will you look at the account and state what are the dates? A. I produce the account of payments (fyled as Exhibit A 16.)

Q. At that time the Plaintiff had been Manager of the *General Phosphate Corporation for some length of time?* A. Yes; some little length of time.

Q. And I suppose you were aware of the fact? A. He said so himself.

Q. You mean that he told you so? A. Yes; he told me so.

CROSS-EXAMINED.

Q. Who is Mr. Sando that is referred to in the correspondence and letters produced with your examination in chief? A. He was the promoter of the General Phosphate Corporation.

Q. Is that the party who is referred to in Exhibit "A 13?" A. Yes.

Q. Did he take any part in assisting in bringing about the sale referred to in Exhibit "A 1?" A. Yes.

Q. What part? (Objected to as illegal and irrelevant, and as not arising out of the examination in chief, and as being inadmissible from the mouth of the Defendant himself.) A. He took the part of the promoter.

Q. How do you mean? Promoter of what? Of the sale? A. Promoter of the Company that purchased the property.

Q. Did he take any part in negotiating the sale? A. Yes.

Q. At whose request? A. At my request.

Q. Did he get any part of the proceeds of the sale for those services, and if so, what portion? (Objected to as irrelevant. Objection reserved.) A. Yes; he did. He got £11,000.

Q. How did you happen to make the arrangement with him to give him that amount? (Objected to as above.) A. I made an arrangement with him to sell the property for £29,000, and he sold it to the Corporation for £40,000. He was to keep what he got over the £29,000.

Q. Did he keep it? A. He did. (Objected to as above.)

Q. And the balance; what became of this £10,000 that was retained as security for the delivery of a certain quantity of phosphate in the City of Montreal? (Objected to as inadmissible from the mouth of the Defendant Objection reserved.) A. The £10,000 was forfeited owing to my not fulfilling my contract, and I received £1,000 cash and 3,000 shares as representing £10.0.

Q. That was the basis of your settlement with the Company? A. Yes.

Q. Have you any agreement of that nature with you? A. Mr. Benson is on his way out with those papers.

Q. When do you expect him? A. I expect him here to-day.

Q. What would be the value of this £3,000 of debentures? (Objected to as above.) A. They would not be of much value just now, as they are not on change, and not negotiable just now.

Q. Would they have any monetary value at present? A. I do not think so.

Q. It depends on the success of the enterprise? A. Yes. (Objected to as above.)

Q. What cash have you netted from the disposal of this property? (Objected to as above.) A. £18,600.

Q. After the payment of commissions? A. No; Subject to my commissions.

Q. That is over and above the commissions that you have paid? A. I do not understand your question.

Q. That is what you had left after you paid the commissions—after you paid for the disposal of the properties and the securities—after you paid Mr. Sando and the other parties? A. Yes.

Q. What do you mean in your examination in chief when you said you had "discontinued" your connection with the contract? A. Because the contract is taken off my hands.

Q. Have you no longer any connection with the General Phosphate Co.? A. No, not any connection in the contract.

Q. They relieved you of the contract? A. Yes.

Q. But in consideration of your giving up the £10,000 referred to in your contract they have given you £1,000 in money, and debentures to the extent of £3,000.

Objected to as above, and further as being leading and suggestive.

A. Yes.

Q. Where was the agreement made? A. In England.

Q. Through whom? A. Through Alexander Benson, my attorney.

Q. Who chiefly carried on negotiations for the sale of this property? A. Mr. Sando.

Q. Was it necessary that you should pay these commissions in order to dispose of the property at the rate it was disposed of?

Objected to as above.

A. Yes.

Q. Had you tried to dispose of it before cabling Mr. Sando? A. Yes.

Q. Had you succeeded. A. No.

Q. What cheque is referred to in exhibit "A 4," and what was it given for? A. I presume it was a balance owing to Mr. Wills for reporting on properties for me.

Q. Had you paid Mr. Wills anything for making reports in connection with any of your properties apart from what is referred to in exhibit "A 16" before that? A. Yes.

Q. How much had you paid him altogether? A. I do not recollect—perhaps $250 or $300, or somewhere there.

Q. That was before that? A. Yes.

Q. Had the services which you have referred to, or the dealings that you had with Mr. Wills in 1888, or thereabout, any connection with the services which were referred to in the letter, plaintiff's exhibit "A 17" A. No.

Q. What was this sum of $250 or $300 that you speak of as having been previously paid to Mr. Wills paid for? A. For reporting on the High Falls property!

Q. Is that the property referred to in exhibit "A 1?" A. Yes.

Q. Is it included in this property? A. Yes, it is included in it.

Q. When you employed Mr. Wills in 1888 or thereabout, did you pay him for his services? A. Yes, I paid him for all his services.

Q. When were these reports made that you paid him for? A. In 1888 or 1889. I am not sure as to the year. It is thereabout.

Q. I notice in this letter exhibit "A 1" the following quotation. "In consideration of your professional services rendered." When had these services been rendered?

Objected to as illegal and irrelevant and not arising out of the examination and as inadmissible from the defendant.

Objection reserved.

A. It was in connection with his services rendered all along I suppose.

Q. When was it that Mr. Wills began to render the services which are referred to in this letter—how long before the signing of that letter? A. I could not say how far back they refer to.

Q. About how long? A. It might have been six months.

Q. Did you ever request Mr. Wills to be present at the signing of this contract exhibit "A 1?" A. No, I have no recollection of ever asking him.

Q. Did you ever ask him to take part in the preparation of it. A. No.

Q. Who saw to the preparation of it? Who got up the contract? A. My solicitor and the Corporation's solicitor.

Q. Who were looking after your interests at the time? A. Hooper & Babcock, my solicitors.

Q. Did Mr. Sando take any part in it? A. Yes.

Q. At your request? A. Yes, at my request.

Q. Was he looking after your interests when it was being prepared? A. Yes.

Q. When you paid Mr. Wills the other items which are not referred to in exhibit "A 16," did you pay him by cheque or in what manner? A. I paid him both by cheque and by money delivered.

Q. Did you take receipts for them? A. Yes.

Q. Have you got them in your possession now? A. Not here.

RE-EXAMINED.

The amount which you have paid to Mr. Wills on account of commission due under exhibit No. 1, is as you have stated in your examination in chief, I believe, the sum of $2,141.30? A. I paid him $2,171.

Q. But the sum paid on account of the commission was as stated by you in your examination in chief $2,140? A. About that.

Q. You and Mr. Wills had other little transactions I believe during the year 1891? A. I do not know what transaction you refer to.

Q. Of a personal nature—small transactions, money which Mr. Wills has advanced to you? A. Has advanced for me?

Q. Yes? A. I do not know of it.

Q. Will you please look at the account now shown you as plaintiff's exhibit "A 17" and state if the charges therein mentioned, of $2.45, $3.25, $4.25, $5, $9.62 and $3 are amounts that were paid by Mr. Wills for your benefit?

Objected to as irrelevant having nothing to do with the present action. Objection reserved.

A. Mr. Wills did not pay all this money for me, on my account.

Q. On whose account did he pay it? A. Some of it on account of the Corporation.

Q. Is it not a fact that you and Mr. Wills had an account current between you during the year 1891 altogether apart from this question of the commission due him on this transaction? A. I do not know that.

Q. Is it not true that Mr. Wills advanced certain sums for you in connection with the account of one Brasseau, which sums you paid him back?

Objected to as irrelevant to the present issue.

Quirk vs. New Rockland Slate Co.

The plaintiff was appointed expert by the court to act with two others in a suit to which the defendants were parties. He now brought suit for his fees. The defence was that the action was prematurely brought because the action was still pending. The court held, however, that experts are not obliged to wait for the payment of their fees until the case is decided. The plaintiff got his bill taxed, which has the force of *chose jugee*. Judgment in favor of plaintiff for $353.50.

Duty on Coal Oil.

(Proceedings House of Commons, 30th May, 1892.)

Mr. MACDONALD (Huron) (for Mr. CAMPBELL) moved for:—

"Return showing the quantity of coal oil, and also kerosene oil, imported for consumption in Canada from the 1st day of July, 1891, up to the 1st day of May, 1892. Also, the amount of duty collected on the same."

He said: The coal oil question has now become one of great importance, and we hear much about it in election times. The people complain of the excessive price of coal oil in this country compared with the price of that article on the other side of the line. As a large amount of coal oil is used in this country, more particularly by the working classes and the farmers, and as the residents in towns and cities have resorted largely to electric and gas light, therefore a large additional expenditure falls upon the poorer classes of this country who use coal oil. I am not opposed to the National Policy in respect to coal oil, because free trade in oil would be unjust to the oil men; but I am opposed to the excessive duty of over 100 per cent. in favour of the coal interest, because this enables them to control the whole industry, and gives them a monopoly in the industry of refining oil. When we consider the quantity of oil used in this country, the excessive duty becomes a very heavy burden upon those who use coal oil. I consider that the refiners of Canada have a monopoly in the industry of refining oil, and this monopoly imposes a much higher price upon that article than they would be able to do if the duty was reduced considerably. The duty now is 7½ cents per gallon. We imported in 1890-91, 5,070,000 gallons, according to the Trade and Navigation Returns, upon which we collected $365,000. Now, it would be supposed, at first glance that $365,000 was the amount of duty paid, but that is not the fact. The duty on coal oil is 7½ cents per gallon, then there is 1 cent for inspection, and 1 cent rate on barrel, which makes 9½ cents protective duty on coal oil in favor of the refiners of Canada. The amount comes to $466,000 between the duty direct and payment for inspection and duty on barrels. Coal oil is imported from the other side by wholesale dealers. They are supposed to make their price on the cost of the article, together with the duty and other charges. The profit of the wholesale importer, 20 per cent., which is the ordinary price charged, will amount, on a total duty and charges of $466,440, to $93,288, which would make the duty and the increased price, by reason of the duty, before it leaves the hands of the wholesale importer, $559,728. The oil passes from the wholesaleman to small dealers, and they, of course, place on an average 40 per cent. of profit on the article owing to the difficulty of keeping oil, and the heavy insurance involved. 40 per cent. on $559,728 gives $223,728, which will be charged as profit on the original duty and the profit of the wholesale merchant, which would make the total, by reason of the duty, $783,639, or nearly 15½ cents per gallon. Suppose the duty was wholly removed, the account would stand thus: The original cost of No. 1 white American oil at the present time is 7 cents per gallon in Buffalo.

Mr. SPROULE. Is that wine gallon or imperial gallon?

Mr. MACDONALD (Huron). Imperial gallon.

Some hon. MEMBERS. No.

Mr. MACDONALD (Huron). It is not wine gallon, which is somewhat less than imperial. Placing the profit of the importer at 20 per cent., the cost would be increased by 1·4 cent, and giving the small dealers 40 per cent. profit, as I did in the other case, it would amount to 3·4 cents, which would place the cost to the retailers at 11·8 cents per gallon if the duty were removed. If you add 11·8 cents to 15·4 cents, the exact figures in the other case, you get 27.24 as the price of American oil sold in the Canadian market. It will thus be seen that my calculation is perfectly correct, because from 27 cents to 30 cents per gallon is the price of American oil at retail in the Canadian market. Some accounts put in by the Government showed that the American oil cost them 30 cents per gallon. Let me give another calculation. It will thus be seen that the increased cost of imported oil is $783,639 by reason of the duty. How much do we increase it by reason of the increased price when the duty enables the Canadian manufacturers to put on as an extra price by reason of this duty by which they are protected? The Canadian people consume about 15,000,000 gallons of coal oil, 10,000,000 gallons of Canadian, in addition to 5,000,000 imported. The wholesale price of Canadian oil at the present time is about 11½ cents, or rather it was 12 cents when I obtained the quotation. Supposing the duty were reduced, we would at least bring American oil down to the same price as Canadian oil, because Canadian oil is of a much inferior quality. We would, therefore, obtain it at 7 cents per gallon wholesale if we could obtain American oil for 7 cents in American markets: that is to say, 11 cents higher than the price for which we would be able to obtain it if we had reciprocity, or 4 cents more than if we had a reasonable duty—60 or 70 per cent. instead of 100 to 125 per cent. The total cost of the 10,000,000 gallons of Canadian oil in the wholesale market would be $1,200,000. I exclude from this calculation the wholesale merchants, because Canadian retailers generally deal direct with Canadian refineries, and the middlemen do not appear so much as dealers in the Canadian article as they do with respect to American oil. Taking 40 per cent. profit to retailers on this sum of $1,200,000, we have $480,000 as the increased price of the oil, by reason of the duty, which is given to the Canadian refiners as a protection. This brings the selling price up to $1,780,000. If the price of Canadian oil were to fall 7 cents, the price of American oil, the total amount at wholesale price and 40 per cent. profit would be $980,000, as compared with $1,680,000, or a saving to the Canadian people on Canadian oil alone of $700,000. Adding that $700,000 to $783,639, which is the amount paid as duty and inspection and duty on barrels by the Canadian consumer on imported oil, we have a total amount as the result of the duty of $1,473,639. We will be met with the argument that this large duty is necessary to sustain and develop the oil industry in Canada. A few words, therefore, in regard to that industry will be in order. In 1881 the refineries of Canada employed 379 men. According to the last census bulletin, No. 8, the oil refineries of Canada, numbering 20, employed 270 men, or after ten years of protection, 109 less than in 1881. Again, it would pay the Canadian people to superannuate every man who is engaged in the refining business in this country. What would be the cost? We have 270 men to deal with. The average wages of mechanics in cities and towns in 1889 was $447. So these 270 men would earn $120,690 a year. Suppose the country undertook, in addition to superannuating the men, to buy up all the tools and machinery in those refineries. According to the last census bulletin, the value of machinery and tools in those refineries was $516,510. Further, it would pay the country to pension every one of the refiners at $10,000 each. There are 20 refineries, and accordingly the sum required would be $200,000. The total cost, first, of superannuating the men; second, of purchasing the machinery and tools of the refineries; and third, of superannuating every refiner, would be $836,200, or a saving of $647,439. No hon. gentleman on either side of the House can fail to see the fallacy of protecting an industry which collects from the people such a large sum of money as does the coal oil industry, and, as I said at the beginning of my remarks, although I am favourable to extending to these men a reasonable protection, it is wrong, I think, in the interest of the consuming population of this country, to extend to the refiners a protection of 100 or

125 per cent. I believe that the Government should take this matter into their serious consideration, and determine whether the oil refiners of this country should receive more protection than the average manufacturers in the other districts in Canada. If the Government should come to the conclusion to reduce the duty on coal oil, they will be doing what is largely in the interests of the people, who are obliged to use a large quantity of coal oil every year. It is an article of prime necessity, it is not an article of luxury; it must be used by the masses of the people, and it should therefore be placed at their disposal at as cheap a price as possible. It was stated in the House last year that the lowering of the duty on sugar removed a burden of taxation off the shoulders of the people. The result of that very good act on the part of the Government was that the price of sugar fell in the market, and the consuming public were able to buy it cheaper. In the same way, if the Government should reduce the duty on coal oil from 7½ to, say, 5 cents a gallon, it would relieve the people of at least one third of the burden which they are now obliged to bear in this matter. I am quite sure that if the duty were lessened the people would receive a corresponding benefit. It was for that reason that I moved for these papers, so that we may learn whether as large a quantity of coal oil is imported as before, and also for the reason that the matter may be brought to the attention of the Government. I hope they will consider this question—not upon the basis of free trade, because I do not contend that coal oil should be put upon the free list; for so long as we have the National Policy in this country, it is only right, and equitable, that protection should be given to the oil producers as well as to every other industry, along the lines of justice. I, therefore, trust that the Government will try to see their way clear to reduce the duty upon coal oil to 5 cents a gallon.

Motion agreed to.

Recent Amendments to the Mineral Act of British Columbia.

The following excerpts from the Mineral Act, as recently amended, are of interest: —

Sec. 11 of the Act, as amended, limits the free miner's right to cut timber to "such timber as may be required for the purposes of the claim or claims worked by him alone, or by him in partnership with another or others."

Secs. 14 and 15 have been repealed and are replaced by the following, to which careful attention should be given by every prospector: —

"14. Any free miner desiring to locate a mineral claim shall, subject to the provisions of this Act with respect to land which may be used for mining, enter upon the same and locate a plot of ground, where possible not exceeding 1,500 feet in length by 1,500 feet in breadth, in a rectangular form, that is to say, all the angles shall be right angles, but the lines need not necessarily be meridianal. In defining the size of a mineral claim it shall be measured horizontally, irrespective of inequalities on the surface of the ground.

"15. A mineral claim shall be marked by two posts, each post being at least 4 inches square and 4 feet above the surface of the ground. The posts shall be numbered 1 and 2, and upon each post shall be written the name given to the mineral claim the date of the location and the name of the locator. Upon No. 1 post there shall be written, in addition to the foregoing, "Initial post," the approximate compass bearing of No. 2 post, and a statement as to whether the claim lies to the right or left of the line from No. 1 to No. 2. Thus: '(Name of claim),' '(date),' 'A. B.'s claim,' 'Initial post,' 'direction of No. 2, northeast,' claim lies to right (or left) of line from No 1 to No. 2 post.

"It shall not be lawful to move No. 1 post, neither shall it be lawful to move No. 2 post, except for the correction of distance by the Provincial Government surveyor. Nos. 1 and 2 posts shall govern the direction of one side of the claim.

"(a). The owner of a mineral claim shall be entitled to all minerals which may be within his claim, but he shall not be entitled to mine outside the boundary lines of his claim continued vertically downwards.

"(6). This Act shall not prejudice the rights of claim owners who have located their claims under former Acts."

Sec. 24 is amended to allow work done outside a claim to count as assessment work, provided the Gold Commissioner is satisfied it is a bona fide development work. This section also now gives partners right to do statutory the assessments for all or any one of a group of claims, provided they file a declaration of their intention with the Gold Commissioner.

Sec. 25 now reads: "In case of any dispute as to the title to a mineral claim, priority of record will determine the right, subject to any question as to the validity of the record, and subject also to the compliance by the free miner with the provisions of this Act.

Sec. 37 is amended so as to lay more on the shoulders of an adverse claimant. Such claimant must now, without any demand on the part of the defendant, "show, with reasonable particularity, the nature, boundaries and extent of such adverse claim."

By Sec. 56 the plan of a claim required, when a certificate of improvement is applied for, must now be made by an authorized land surveyor.

These are some of the main changes. A section now entitles the free miner to a copy of the amended Act on payment of 25 cents.

Nova Scotia's Increased Royalty.

Coal Lessees. "But our leases explicitly state that the rate of royalty is fixed for the current term. How can you increase it at will without a breach of faith?"

Premier. "Needs must when the devil drives; and you must understand the Legislature of Nova Scotia has the power to break a contract or to take your property without compensation; but I may tell you the Attorney-General says there is no breach of faith."*

Coal Lessees. "We are differently advised, still, so content are we that moral justice and right is on our side that we are ready to leave the question to arbitration or the Courts. Will you agree?"

Premier. "No; the supreme Court sometimes makes mistakes."*

The Premier of Nova Scotia is now in England seeking to raise money on the good faith of the Legislature of Nova Scotia.

Mineral Resources of the Yukon and Mackenzie Districts—A Great Petroleum Field—Promising Alluvial Diggings.

Contributed by A. M.

North of the great plains, along the Athabasca, Peace, and Mackenzie rivers, are situated a number of petroleum districts, the total area of which probably exceeds that of all the known oil fields in the world combined. On the Athabasca indications of gas and oil occur along the valley for a distance of over two hundred miles. The basement rocks here consist of petroliferous Devonian limestones. Resting on these is a thick stratum of soft sands of Cretaceous age, which has been blackened and cemented into a coherent tarry mass by the floods of oil which have welled up in bygone ages from the underlying limestones. The tar sands are first seen in descending the Athabasca, at the Boiler Rapid, or about 170 miles below the "Athabasca Landing," and are there present in bluffs along the valley for a distance of over eighty miles. They have, according to the reports of the Geological Survey, a thickness of from 150 to 225 feet, and outcrop at the surface over an area of about a thousand square miles. The tar sands themselves, where exposed, *although 15 to 20 per cent. of their bulk consists of* bitumen, are not supposed to have any great commercial value, as the lighter oils have long since volatilized away, and only the heavier constituents remain. In the upper part of the vein, however, where they are buried beneath the later cretaceous divisions, it is highly probable that the oil remains in its original condition, but the solution of this question depends upon a generous use of the drill.

West of the Athabasca river tar springs are reported on Lesser Slave Lake, and are also known to occur on Peace river. The latter are thus described on Page 11., Summary Report of the Geological Survey for 1889. Inspissated petroleum lining cracks in calcareous nodules was found along Peace river for some sixty miles below the Peace river landing. At Tar Island, about thirty miles below the mouth of Smoky river, there is a saline spring which is kept in a constant state of ebullition by the escape of natural gas. Small quantities of tar line the sides of the spring and float on the surface of the water. This spring, and a couple of others which are reported nearby, are situated near the axis of a broad flat anticlinal, one of the essential conditions of a successful oil field. Gas and oil in paying quantities are most frequently found in these great natural domes, and the only element of uncertainty in this district is the presence or absence of some porous formation to act as a reservoir. It is possible that the loose sands found along the Athabasca extend this far, or that some equivalent formation occupies their place; but as natural sections are wanting, this can only be proved by artificial sections obtained by boring.

North of the Athabasca oil region, tar springs are known to occur along the northern shore of Great Slave Lake, and petroliferous limestones floor the valley of the Mackenzie nearly all the way to its mouth. At Fort Good Hope, a few miles south of the Arctic Circle, are situated the tar springs from which the Hudson Bay Company obtain the pitch used by them for boat building purposes.

Favorable indications of the presence of oil, in the shape of tar sands, tar springs, effusions of natural gas, and petroliferous limestones, are thus seen to characterize the country bordering on the Mackenzie-Athabasca valley for a distance measuring from the south to north of over a thousand miles. It is highly improbable that productive oil beds are continuous throughout the whole of this vast region, but there is every reason to believe that over a considerable proportion of it the oil is sufficiently concentrated to be of economic value. Up to the present time the remoteness of these northern oil fields from the centres of civilization has prevented any attention from being directed towards them, but the expected completion of the Calgary and Edmonton Railway during the coming summer will place them within a reasonable distance from railway communication, and they will probably soon take their place among the oil producing regions of the world.

West of the Rocky Mountains, in the great country drained by the Yukon and its tributaries, the geological conditions are entirely different from those prevailing in the Mackenzie Basin. This region lies in the auriferous zone which borders the western part of the continent, and the gold-bearing belt, according to the reports of the members of the "Yukon Exploring Expedition," appears to have lost none of its wonderful richness in its extension northwards. Miners entered the district about the year 1881, and the prospecting which has been carried on since then has shown that gold is of almost universal occurrence, although only in some places is it found in sufficient quantities to be profitably worked in the face of the high prices prevailing for labour and provisions. Stewart River and Forty Mile Creek are the richest streams so far discovered. The former yielded over $100,000 worth of gold to a handful of miners during the years 1885-86, some of the bars paying as much as $100 per day per man. The gold on Forty Mile Creek is reported to be richer than that on the Stewart, but the greater part of this stream lies in Alaskan territory. The following extract from Dr. Dawson's report will afford some idea of the present condition and future prospects of gold mining in the Yukon country. (Annual Report Geological Survey of Canada, 1887-88, Part I., page 182):

"Mining can scarcely be said to have begun in the region more than five years ago, and the extent of country over which gold has been found in greater or less quantity is already very great. Most of the prospecting has been confined to the banks and bars of the larger rivers, and it is only when these innumerable tributary streams begin to be closely searched that 'gulch diggings,' like those of Dease, McDame, and other streams in the Cassiar district, and possibly even on a par with Williams and Lightning creeks, in Cariboo, will be found and worked. The general result so far has been to prove that six large and long veins, the Dewes, Tet-lin-too, Big Salmon, Pelly, Stewart and White, yield "fine-gold" along hundreds of miles of their lower courses. With the exception of the Lewes, no part of the head waters of any of these have yet been prospected or even reached by the miners, and scarcely any of their innumerable tributaries have been examined. The developments made up to this time are sufficient to show that when means of access are improved, important bar mining will take place along all these main rivers, and there is every reason to anticipate that the result of the examination in detail of the smaller streams will be the discovery of much richer auriferous alluviums. When these have been found and worked, quartz mining will doubtless follow, and the prospects for the utilization of this great mining field in the near future appears to me to be very promising."

The Yukon district remains as the last refuge of the placer miner. These pioneers of mining enterprise have gradually advanced northwards, following the auriferous belt from California through Oregon, Washington Territory, and British Columbia, and are now spreading themselves in the face of difficulties and dangers from which all but the bravest and strongest quail over this inhospitable region. In the progress of their work the metalliferous lodes from which the loose gold has been derived will, as in other districts, be gradually discovered, and mining ventures of a more solid character will follow.

Extraction of Ore from Wide Veins or Masses.*

By G. D. Delprat, London, Eng.

The object of this paper is to describe an application of the cross-cut system of mining, as carried on in the Cabezas del Pasto mine, one of the copper mines in the south of Spain. The system is not new, but it is not very generally adopted. It offers, however, decided advantages over other systems more in use; especially where the ore is found in large masses or wide lodes, it allows the extraction of all the ore without leaving any pillars or roofs. A somewhat detailed description of the various operations and costs of working may not only be interesting, but may possibly lead to a more general adoption of this method in cases where at present the pillar-and-stall system is preferred.

The copper-lodes in the south of Spain and Portugal are the following: They are nearly all lenticular masses of great lateral dimensions and unascertained depth; their direction is approximately east-west, and their dip towards north. Some are contact-lodes, having slate on the hanging-wall and porphyry on the foot-wall; others are imbedded in porphyry, and others again are imbedded in clay-slate.

The upper portion of these lodes consists of "gossan," a siliceous peroxide of iron, mixed with more or less clay. The depth to which the gossan goes down varies in different localities from 40 feet to 120 feet and more. Below the gossan is found the iron-pyrites, with about 2 to 3 per cent. of copper. The gossan is generally admitted to be the result of the decomposition of the pyrites, the copper rendered soluble, filtering into the underlying layers of undecomposed ore, and enriching the ore below the gossan above the general average. Very rich pockets and streaks of ore, containing sometimes 10 per cent. of copper and more, are often found in the upper portions of the lodes. The copper contained in the ore is generally in the shape of gray and black sulphides and copper-pyrites; rich pockets often show chalcopyrite and fahlerz. In nearly all the mines the ore has been found to get poorer in copper with greater depth; a cross-section through the Cabezas del Pasto mine shows this diminution, and may be taken as a fairly representative case. The greater the lateral dimensions of a deposit, the greater is generally the depth down to which a fair percentage of copper is found.

In the Rio Tinto mines, which are the largest copper mines in Spain, a depth of 700 feet has been reached in

*Actual expressions used.

*Transactions of the February meeting of the American Institute of Mining Engineers.

some places without any marked decrease in copper contents; but the length and width of the Rio Tinto deposits are enormous, one of them being more than half a mile in length, and in some places more than 300 feet wide—all solid ore.

In the Tharsis mines, the next in importance, poor ore has been found at much less depth, the lateral dimensions of the deposits being smaller. In most of the smaller mines the ore gets too poor to be worked at a profit at a depth less than 300 feet. One per cent. of copper is generally taken as the limit of workable ore.

The following is a complete analysis of a fairly representative sample of ore from the Rio Tinto mines:—

Sulphur	48·3
Copper	3·44
Iron	43·33
Bismuth	·02
Lime	·34
Lead	1·00
Gold	·00005
Silver	·004
Cobalt	·05
Arsenic	·75
Antimony	·07
Calcium oxide	·23
Manganese	·05
Silica	1·89
Moisture	·48
Selenium	traces.
	99·95405

There are some exceptional deposits which are of a different nature, such as the "Esperanza," near Tharsis, where the copper is found as a sulphide impregnating the slate, but they need not here be mentioned.

The ore is generally sorted by hand into two classes. The richer ore is sent to England and the Continent, to the sulphuric acid manufacturers (who, after burning off the acid, send the residue to the copper works), and the purer ore is generally treated for copper only in proximity to the mines.

Two systems of mining are very generally adopted.

When the gossan is comparatively shallow and the mineral mass is wide, the ore is generally got by open-cast working; the overburden is removed in benches about 30 feet high, and the ore thus laid bare is quarried.

The cost of removing the overburden varies with the nature of the ground and with the facilities for getting proper dumping facilities. The following statement shows the average cost over a whole year in the "Joya" mine, which is worked by the open-cast system. The greater part of the material removed is decomposed porphyry, and, as a rule, fairly hard.

Cost of Removing Overburden at the "Joya" Mine, per Cubic yard in the Solid (calculated on the total quantity removed during 1891).

Labor.—Superintendence	$0.009	
Excavation	0.032	
Loading into waggons	0 049	
Mule-drivers	0.005	
Unloading waggons and repairing roads	0.016	
Various	0.001	—$0·112
Materials.—Explosives		
Baskets (used for loading waggons		
Railway material		
Waggon "		
Oil and grease		
Various		— 0·011
Shops		0·006
Stable expenses (mules)		0·013
Tools		0 003
Amortisation of railway material		0·005
Total cost per cubic yard		$ 0.15

The open-cast working is certainly the best system in mines where the overburden is shallow and the deposit wide. The limit at which the removal of overburden becomes unprofitable is generally put at 4 cubic yards of overburden for every ton of ore laid bare. The cost of quarrying the ore, after having laid it bare, may be taken as follows, exclusive of general charges:—

Cost of Quarrying Ore in the Open-cast in the "Joya" Mine per Ton of 1000 Kilos (Average for the Year 1891).

Breaking the Ore.—Miners	$0.038	
Materials, explosives	0.012	
Shops	0.004	
Tools	0 005	—$0.059
Loading into waggons		0.038
Weighing		0.003
Total cost per ton, put into waggons and weighed		$0 10

Examples of open-cast working are found at the Rio Tinto (south lode), Santo Domingo, Tharsis (north lode, Sierra Bullones, and centre lode) La Zarza, La Joya, Las Herrerias, Lagunazo, etc.

When the proportion of overburden is too great, the mine is generally worked on the pillar-and-stall system. The lode is divided off vertically in floors, 30 to 40 feet apart, and in each of these floors galleries and cross-galleries are driven, intersecting one another at right angles, leaving large pillars of mineral to support the roof between the floors. The roof is generally left about 12 to 15 feet thick, and the square pillars have sides of 15 to 20 feet, the galleries being of the same width as the pillars, and about 20 feet high. It is evident, that by adopting this system of working, a large quantity of ore is left in the mine; taking floors 35 feet apart, with a roof of 12 feet, galleries 23 feet high and 16 feet wide, and pillars with sides of 16 feet, the quantity of ore extracted by means of the galleries is only one-half of the total quantity. In several mines considerably less than one-half is extracted. It is generally maintained by those who adopt the pillar-and-stall system that after honeycombing the mass, more ore may be gained by robbing the pillars and roof. This is, however, a very dangerous operation in mines where the lode is nearly vertical, where the width is considerable, the ore very heavy (specific gravity about 5), and where often ten to twenty floors are formed one above another. Only in one mine (the Carpio mine) has this been done, and the result was not encouraging. Only four floors had been formed, yet, although a good deal of ore was extracted by robbing, still, by far the greater part remained in the mine, and could not be got out, the comparatively great height of the galleries being a great element of danger. That the operation of robbing is a very delicate one is confirmed by the fact that most of the mining companies, after extracting all the ore they could get by means of galleries, and finding their ore reserves disappearing, have determined, instead of robbing the pillars, to remove the overburden and quarry the honey-combed mass in the open air. Instances of this are found in many places. It is needless to say that a great deal of money would have been saved if the overburden had been removed from the beginning.

Another disadvantage in connection with the pillar-and-stall system is the great cost of breaking the ore. Although galleries may be driven of considerable dimensions as long as the ore is firm, still, breaking ore in galleries, especially in hard ore, is always very costly. Whilst the breaking of ore in the open-cast may cost $0.07 per ton, the breaking in galleries will cost, on an average, from $0.52 upwards. When the ore is very hard it may be as great as $0.85. The reasons for this higher cost are too evident to need any mention. A miner will break per shift, in galleries, about ¾ of a ton; in the open-cast he will break from 12 to 15 tons of ore, and even more in favorable cases.

Examples of pillar-and-stall workings are found at Rio Tinto, in the San Dionisio lode; at Tharsis, in part of the north lode, and formerly, in the Sierra Bullones and La Zarza Tharsis (both these lodes are now open-cast); at Lagunazo, in the eastern portion of the lode, at Sotiel-Coronado, Pena de Hierro, Lapilla, Aznalcollar, Coridad, etc.

The Cabezas del Pasto mine is worked on a different system, which allows all the ore to be extracted without any danger and at a low cost; and there seems to be no reason why the system should not be adopted in all places where the pillar-and-stall is now used, and where the height of overburden excludes the open-cast system. The mineral deposit at this mine is about 500 feet long, with a width varying from 20 to 75 feet, the average being about 32 feet. The gossan goes down about 100 feet, and it was, therefore, impossible to work the mine by open-cast. The lode is nearly vertical and approximately in the centre of the mass.

After fairly ascertaining the bearing and extent of the lode, an extraction-shaft and a pumping-shaft were sunk in positions outside of the lode. The dimensions of these shafts were 10 feet by 5 feet and 11 feet by 5 feet. The extraction-shaft was divided by a partition in the centre, so as to accommodate two cages. They were originally sunk to a depth of 230 feet, and subsequently deepened to 350 feet.

The lode was then divided in floors about 65 feet apart. From the extraction-shaft galleries were driven at every floor, cross-cutting the lode entirely. When these galleries reached the ore, narrow galleries were driven east and west, following the hanging-wall (the extraction-shaft being in that wall), along all the sinuosities of the lode, and accurately determining its shape. From these galleries, again, cross-cuts were driven through the lode at every 33 feet. After thus learning the exact shape of the lode, a "side-tie" was driven in the country-rock, alongside the lode and at an average distance of about 15 feet, and from this side-tie cross-cuts were driven towards the lode at regular intervals of 33 feet. The side-tie was kept nearly straight and was used as an extraction-gallery; a tramway of 2-foot gauge, with rails of 30 pounds to the yard, being laid in it. There were various reasons why the gallery along the wall of the lode was not utilized as an extraction-gallery, the two principal ones being its crookedness, and the fact that it became surrounded by "stowing" or "gobbing," which necessitated constant timbering to keep it open. On one of the levels it was, indeed, attempted to make this gallery serve for extraction, but it was found very difficult and expensive, and quite unsuitable.

Both walls of the lode are slate, in which all galleries had to be closely timbered.

When the cross-cuts from the gallery along the hanging-wall had reached the foot-wall they were filled with stone carefully piled up, and new cross-cuts were then driven alongside the first ones; these were again filled up, and again new ones were made, and so on until a complete slice of ore had been removed over the whole length and width of the deposit. All the galleries and cross-cuts had a uniform size of 6 by 6 feet, so that the height of the first slice removed was 6 feet. When this had been accomplished the gallery along the hanging-wall was filled up and a new gallery was driven right above it. From this new gallery cross-cuts were again driven through the mass and filled up the same way as below, but with one important difference: while the first slice of 6 feet had to be broken out of the solid body of ore, the slice next above was now under-cut over its whole area, in fact it was resting on the packing. This made the blasting very much cheaper; so that, whereas the contract price given to the miners in the first slice averaged $0.50 per ton of ore, it was only $0.25 in the slice next above. Again, in the first slice the first cross-cuts in the solid ore cost $0.76 per ton of ore, and the secondary cross-cuts, which were really widening out the first ones, only cost $0.42 per ton. These figures show the enormous advantage of having free sides for the working faces—an advantage, by the way, which is never got in working by pillar-and-stall. After the second slice had been removed a third was taken away in the same manner, and so on until the whole lift of 65 feet was removed. The working was not limited, however, to one lift or level, but three were attacked simultaneously in the same manner; and at the present day the second, third and fourth levels are in active work, and the fifth is in preparation.

It might be expected that some difficulty would be experienced when workings of one floor reach the stowing of the floor above. In practice, however, it is found that the stowing gets so tightly packed as to be quite firm, and with a little additional care it is comparatively easy to mine below it. No galleries nor cross-cuts were made more than 6 feet high and 6 feet wide, and no new cross-cut was started before the adjoining one had been properly filled in.

During the filling-in of the gallery on the hanging-wall a chute was built up in rough stone, above the cross-cut, from the side-tie. Through this chute the ore from the second slice was thrown down to the cross-cut. When the second slice had been removed and the next gallery filled in, these chutes were carried up, and so on; and these always served for sending the ore down to the cross-cuts, and thence to the side-tie, where the ore was loaded into wooden hutches holding about one-half ton each, and subsequently trammed to the extraction-shaft.

The material used for stowing is quartzite. This is quarried on the top of a hill, about 700 yards from the lode. The stone is lowered by means of an inclined plane to the level of the mouths of two special shafts sunk for the purpose of delivering stone to the workings, and extending at present to the third level, with loading platforms at each floor. The stone, loaded in hutches similar to those used for the ore, is lowered in these shafts by means of double drums, with brakes, the full waggon going down pulling up the empty one. The stone required in the fourth level is landed in the third level and trammed through the extraction-gallery of this level. This extraction-level is connected with the workings below by means of winzes; the stone is tipped into the winzes and falls almost at the foot of the workings to be filled up. As the slices are removed these winzes get filled up also, and therefore gradually disappear, while the ore-chutes always get longer. Each level is thus supplied with stone from the floor above, and the stone need never be raised by hand. All the winzes for throwing down stone are made in the hanging-wall; they are about 3 feet square and very securely timbered.

A good deal of small stuff is produced in the quarry. At various times trials were made to use these smalls in filling up, as it seemed a pity to throw them away. It was found, however, not economical to do this, as the smalls were more expensive to handle in the mine than the big stones, and also because stowing done with smalls settles down far too much, and loosens the ore above to a dangerous extent, making a very treacherous roof in the workings higher up.

The stowing with large stones is so firm that no subsidence of the ground over the mine can be noticed, although a very large quantity of ore has already been removed.

This system has now been in operation for eight years, during which a total of 236,000 tons has been extracted. Only one man has been killed by falls of the roof during all this period, which shows that the system is not a dangerous one. All the cross-cuts are kept narrow (6 feet); very few props are used, and even these few are generally taken away before stowing.

The average quantity of ore broken by a miner in this mine is 3 tons per shift of ten hours, as against ¾ ton under the pillar-and-stall system, the difference being due to the ore being always under-cut and requiring little blasting.

The average cost of work in 1891 was, for different parts of the system, as follows:—

	Per Ton
First cross-cuts in the solid ore	$0.76
Cross-cuts	0.42
First cross-cuts in next slice	0.28
Following cross-cuts, etc	0.24

This shows the increased economy in breaking when the ore is under-cut.

The cost of extraction for the year 1890 was as follows:—

Cost per Ton, apart from General Expenses.

Labor.—Superintendence	$0.0128	
Breaking the ore	0.2372	
Loading into waggons and tramming	0.0501	
Engine-men, etc	0.0362	
Stowing	0.1569	
Timbering	0.0152	
Unwatering	0.0048	
Various	0.0078	—$0.521

Shops.—Carpenter shop	0.0091	
Smithy	0.0148—	0.024
Materials.—Explosives	0.0436	
Coal	0.0353	
Timber	00.331	
Steel	0.0022	
Caskets	0.0074	
Grease	0.0078	
Various	0.0031—	0.132
Tools	0.0091	
Depreciation of machinery	0.0273	
" waggons and rails	0.0035 —	0.040
Total per ton	$0.717	

The cost of stowing per cubic yard may be detailed as follows, one cubic yard corresponding to about 2·7 tons of ore :—

Cost per Cubic Yard for 1890.

Superintendence	$0.0114
Quarrying stone, inclusive of explosives	0 0556
Throwing small stuff over dumps	0.0530
Transport of stone to shafts and lowering down in shafts	0.0931
Underground transport from shafts to winzes and topping	0.0654
Underground transport from winzes to workings	0.0720
Building up in workings	0.0360
Various	0.0164
Total per cubic yard	$0.40

For the better appreciation of these cost-sheets I may here give the average daily wages earned by workmen in the district :—

Wages Earned Per Day.

	Reals.	Dollars.
Foreman of the mine	24	1.00
Engine-drivers	20	0.87
Stokers	10	0.43
Carpenters	20	0.87
Smiths	20	0.87
Masons	16	0.70
Miners	12 to 16	0.52 to 0.70
Trammers	12	0.52
Ordinary laborers	10	0.43
Boys and girls	6 to 8	0.26 to 0.35
Cost of coal	150	6.54
" firewood	45	2.00
" six foot props, each	10	0.43

The following is the cost of a ton of ore, mined by the pillar-and-stall system, where other conditions are the same as above :—

Cost of Pillar-and-Stall System Per Ton of Ore.

Labor.—Superintendance	$0.0128	
Breaking the ore	0.6540	
Loading into waggons and tramming	0.0501	
Engine-men, etc.	0.0362	
Timbering	0.0152	
Unwatering	0.0038	
Various	0.0078—	$0.781
Shops		0.024
Materials		0.132
Tools		0.009
Depreciation		0.031
Total per ton		$0.977

The cheaper working over the pillar-and-stall system is entirely on account of the cheaper breaking of the ore, the difference being about $0.26 per ton.

The system here described was started by Mr. C. Roepel, M.E., and subsequently carried on by the writer and Mr. P. E. Carr, M.E. It can be applied in all large masses and wide lodes, and is a safe and economical mode of getting all the ore.

The Cabezas del Pasto mine is one of the mines worked by the Bede Metal and Chemical Company, Limited, of Newcastle-on-Tyne.

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MINING NOTES.

[From Our Own Correspondents.]

Ontario.

Port Arthur District.

The mill of the Badger Silver Mining and Milling Co. resumed operations on Tuesday, 24th ult., and the mine is also being worked. There was some slight trouble that necessitated the closing down of the mine and mill for a few days, but we are pleased to say that we have been informed that the trouble has been amicably settled, and that the mine will be worked steadily by a large force of men.

A report reaches us that the owners of the iron locations near Kaministiquia intend opening up and developing their property. It is also said that the company is in communication with the C.P.R. company with the view of having a spur run from the main line to the location.

The British Columbia Iron Works Company are now making a large boiler for the Westminster Slate Company's quarry at Jervis Inlet. The boiler is five feet wide, and sixteen feet long.

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Annual Report, 1888-89,

VOL. IV.

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Part S (a).—Mining and Mineral Statistics, 1888, by H. P. Brumell. Out of print.

Part S (b).—Mineral Statistics and Mines, 1889, by E. D. Ingall and H. P. Brumell. Price 25 cents.

Part T.—Annotated List of Minerals occurring in Canada, by G. Christian Hoffmann. Price 25 cents.

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AN ORDINARY

QUARTERLY GENERAL MEETING

OF THE

GENERAL MINING ASSOCIATION

OF THE PROVINCE OF QUEBEC

WILL BE HELD IN

THE ASBESTOS CLUB HOUSE,

BLACK LAKE, QUE.,

ON TUESDAY, 14th JUNE, 1892,

COMMENCING AT HALF-PAST FIVE O'CLOCK IN THE AFTERNOON.

For the convenience of members and their friends attending this meeting a special car will be attached to the ordinary train (Quebec Central Railroad), leaving Sherbrooke, Que., at 8 a.m. on the morning of Tuesday 14th June. Black Lake members will join the party at 10.42 a.m. Train will arrive at Thetford Mines at 10.45 a.m., where some time will be spent in a visit to the Asbestos mines. Lunch will be served at half-past twelve o'clock (noon). Party will leave Thetford Mines at 1.30 p.m., returning to Black Lake by teams kindly furnished by the local Committee.

The ORDINARY QUARTERLY GENERAL MEETING for the reading and discussion of papers, etc., will be held in the

Asbestos Club House, Black Lake,

commencing at 5.30 p.m. Papers will be read by Mr. J. Burley Smith, M.E., Glen Almond, Que., and by Mr. L. A. Klein, M.E., Black Lake. At 7.30 members will be entertained to a dinner given in their honor by the Asbestos mine-owners and mine managers. Train will leave at 1 o'clock a.m. Wednesday, 14th inst., for Sherbrooke, where connection will be made for Montreal and points west. Tickets, $5.50 for the round trip (from Sherbrooke to Thetford and return) may be obtained from the undersigned, or from Mr. A. W. Stevenson, C.A., Treasurer, 17 St. John Street, Montreal.

GEORGE IRVINE, *President.* **B. T. A. BELL,** *Secretary.*

THE ASBESTOS CLUB,

Black Lake, Quebec.

The **General Mining Association of Quebec** will visit Thetford and Black Lake Asbestos Mines on Tuesday, the 14th instant, and the following is the proposed programme, viz. :—

A. Train (Quebec Central Ordinary) will leave Sherbrooke, Que., on Tuesday morning, the 14th of June, at 8 a.m. A special car will be attached for the use of members and their friends, and special rates will be given for return trip tickets to be obtained on board the car.

B. Train will reach Thetford Mines at 10.55 a.m., where the party will be received by the local committee.

C. After an inspection of the Mines, a cold lunch, provided by the Asbestos Club, will be served at 12.30 (noon).

D. The party will be driven in teams to Black Lake, leaving Thetford Mines at 1.30 p.m.

E. The Ordinary Quarterly General Meeting, for the reading of papers and the transaction of business, will be held in the Asbestos Club Room, commencing at 5.30 p.m. The following papers will be read :

"The Labour Question in its Relation to Canadian Mining."
By J. Burley Smith, M.E., Glen Almond, Que.

"Recent Practice in Economical Air Compressors."
By F. A. Halsey (Rand Drill Co.), Sherbrooke.

"The Present Status of the Asbestos Mining Industry in Canada."
By L. A. Klein, Supt. American Asbestos Co., Limited.

F. At 7.30 p.m. members and their freinds will be entertained at Supper by the asbestos mine owners.

Members going South can leave by the 1.20 a.m. Wednesday ; or going North, by the 3.00 a.m. same day.

Members of the Asbestos Club are especially invited to attend.

A. M. EVANS, M.E.,
Secretary-Treasurer.

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Goddard's Patent Grinder and Gold Saver.

Considerable interest has been evinced during the last few weeks, says the *Australian Mining Standard*, in the trials of a new gold-saving appliance, invented and patented by Mr. H. S. Goddard, engineer, of Uralia, New South Wales, who, for over two years has been engaged perfecting the invention. The machine is designed to save floured silver and gold which ordinarily are lost in tailings from batteries, and the several tests and trials, which have been of the most severe character, and have taken place at Langland's foundry, South Melbourne, resulted successfully. Goddard's patent differs from many appliances in its simplicity, efficiency and cheapness. It consists of a circular pan, the bottom and sides of which are lined with grooved hematite iron, in which works a muller, also with grooved bottom and sides, the grooves being placed at opposite angles to those in the pan. The weight of the muller is about 9 cwt., and it revolves in the lined pan at the rate of 150 revolutions per minute, its action on tailings running direct from the battery being to grind them fine as roller flour. The pan is fed from the centre of the muller at the rate of 9 cwt. per hour, and can be automatically fed from a battery, thereby saving an immense amount of labor and attention. After grinding is completed the material passes through the inner amalgamator charged with quicksilver, and the centrifugal action of the muller throws the fine sand over the edge of the pan into a ring well, also charged with quicksilver, so that it is impossible for gold to pass. The sand is kept agitated by several fingers revolving in the outer well, and is there discharged with the waste water at a spot in the outer casing of the machine. The wearing parts being of white hematite iron are very durable and are easily renewed at any time. It is said that the machine now at work will receive and grind as much as can be delivered from a five-head battery, with gratings of 41 holes to the inch, thus effecting a material saving in cost of crushing and treating, leaving the residue finer than that from an ordinary battery. Tables and blankets are entirely dispensed with. The machine is further specially adapted for the treatment of fine gold, and should prove a desirable acquisition where flake or floured gotd is lost.

The *Australian Mining Standard* is informed that it has been successfully tried in the Hillgrove district, in New South Wales, where a quantity of tailings from the Eleanora gold mine, which gave by fire assay 5 dwts. 9 grains, were treated, and resulted in return of 4 dwts. 15 grains. Tailings from Alpine gold mine at Swamp Oak, which assayed by fire 23 dwts., were also put through the pan, giving a result of 21 dwts. A parcel of quartz from the Great Britain claim at the same place, which crushed about 6 ounces, gave 9 ounces 13 dwts. 1 grain. Two tons of tailings from Russell's Amalgamated Company, Victoria, which had been treated at the modern battery of that company, with 240-mesh gratings, gave a return of 2½ dwts. per ton. Another two tons from the same company gave 4 dwts. per ton, both from the new machine. Three trucks of tailings from Eaglehawk district (different claims) are being treated at present : the first lot of two tons gave 3 dwts. to the ton ; the others are being put through, and the amalgam promises encouraging results. A large number of other orders are on hand. The machine can be made in sizes suitable for 5, 10, 15 or 20 head of stamps ; it will feed itself ; is speedier than the usual chlorination process and does not lose a grain of quicksilver.

Novel Process for the Prevention of Scale in Boilers.—In engineering circles considerable interest has been excited over a process which has been discovered for enamelling the interior of boilers, with a view to the prevention of corrosion and incrustation. Experiments have been proceeding with the process for the last three years, and the results are certified by firms in Glasgow to be of a most surprising and successful character. Further tests are being applied, and if what is claimed for the process is definitely attained the gain to engineering generally will be great.

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Under the provisions of chap. 7, Revised Statutes of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of six months, which can be extended by renewal for another six months. Mines of ld and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. Up to ten areas the cost is 50 cts. per area, for every area in addition in same application 25 cents. Cost of renewal one half the original fees. Leases of any number of areas are granted for a term of 21 years at $2-00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and in smelted gold valued at $18.00 an ounce.

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

MINES OTHER THAN GOLD AND SILVER.

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

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

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

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

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones; five per cent.; Coal, 7½ cents on every ton sold.

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

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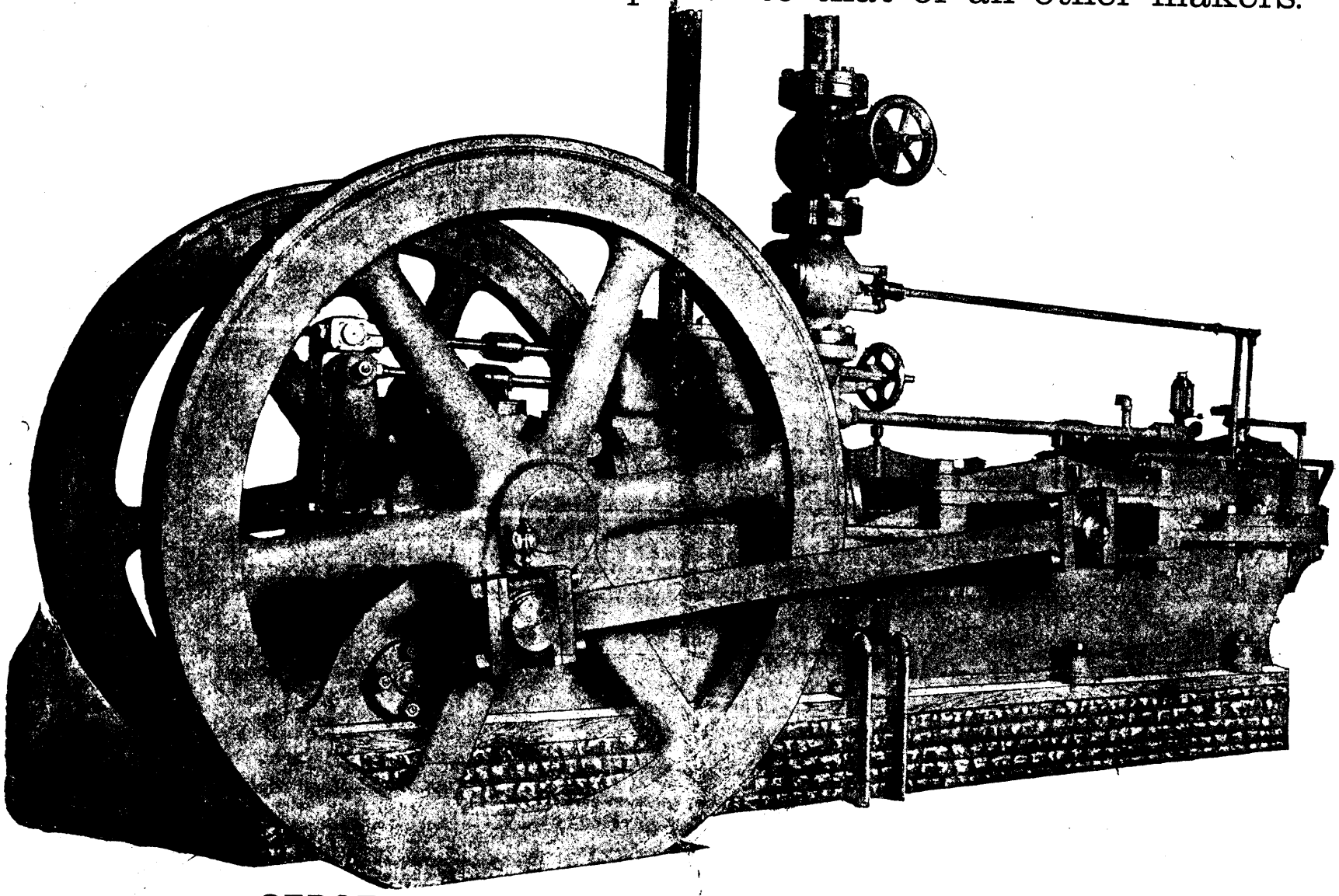

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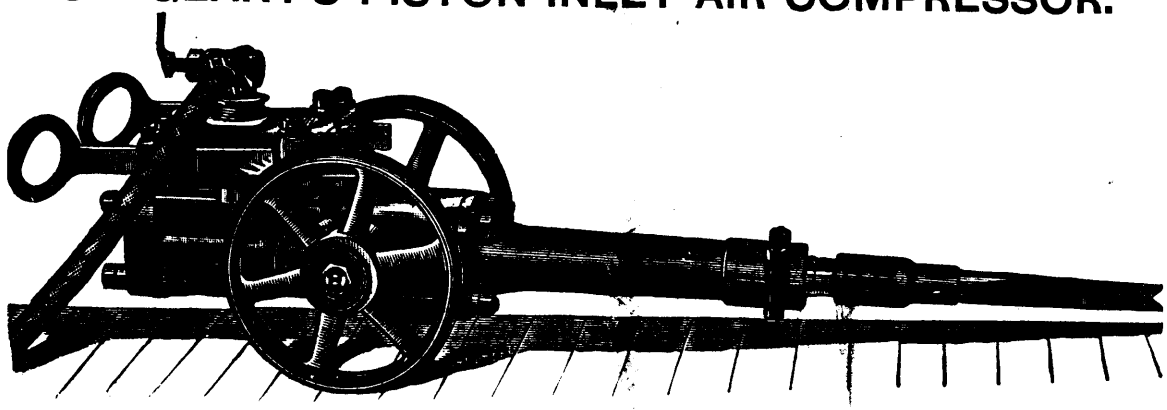

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