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Robert Bell

The Canadian Mining Review

Established 1882

Vol. XII.—No. 8. 1893—OTTAWA, AUGUST—1893. Vol. XII.—No. 8.

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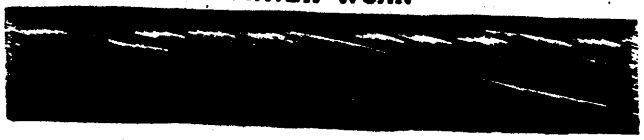

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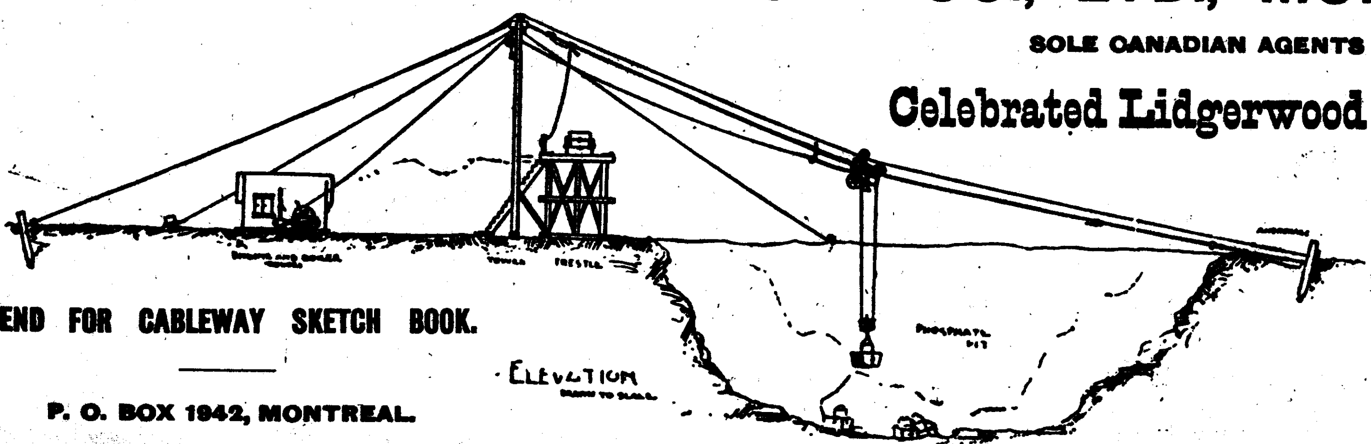

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Vol. XII. AUGUST, 1893. No. 8.

THE OFFICIAL ORGAN

—OF—

THE GOLD MINER'S ASSOCIATION OF NOVA SCOTIA,

THE UNITED MINING SOCIETY OF NOVA SCOTIA,

THE ASBESTOS CLUB, QUEBEC,

THE GENERL MINING SSOCIATION OF QUEBEC

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 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. WYLDE, *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, 1891, 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 IRVINE, *President.*
B. T. A. BELL, *Secretary.*"

The Cape Breton Coal Trade.

Coal mining operations in Cape Breton have been carried on this year without any very noteworthy change from the *modus operandi* of preceding seasons. The winter and early spring months were filled with loud prophecies of impending disaster and ruin to the country, from papers and individuals whose interests—financial or political—were not furthered by the "Whitney Syndicate," so-called, and on the other hand with almost equally wild and absurd prognostications of glorious prosperity and immense benefits to one and all on the part of those disciples of the Hon. W. S. Fielding who were seeking to grind their axes at the Whitney whetstone. The result has been, as might have been foretold by any one acquainted with the shrewd business men who were controlling and putting their money into this venture, that prophecies of spiteful critics, and prognostications of foolish friends have alike proved false. "*Festina lente*" is not a motto that would naturally commend itself to those who, on the one hand, were clamoring for the immediate transformation of Cape Breton into an El Dorado, or, on the other hand, were crying out that the bottom must immediately drop out of the coal trade and of everything connected therewith, but it is the motto that the Dominion Coal Company has evidently adopted for itself at the present juncture. They evince no disposition to spend their money on hastily matured schemes, and are provokingly deaf to the gibes of their numerous critics and advisers, who taunt them with not scattering their money broadcast through the country by undertaking out of hand gigantic operations which have been promised and vowed in their name. None the less, the extension of the railway from Bridgeport to Louisburg is being steadily progressed with, and other works which must entail a heavy expenditure of money, and which will give facilities for mining and shipping coal in increased quantities, are being anxiously and carefully considered, and will assuredly be carried out. In these, as in all other matters affecting their business, the Dominion Coal Co. will, we imagine, be guided entirely by a consideration of their own interests, without reference to the interests of either political party in Nova Scotia. It has been amusing, for an observer outside the arena, to follow the local papers in their attitudes towards the new company. On the one side we find unreasoning and unreasonable opposition all along the line, the manufacturing of unfounded stories of rapacity and tyranny, and the setting up of bogeys in the shape of dreadful consequences that were to follow the change of ownership in the mines, which any driver-boy in the company's employ could have knocked down. On the other hand we find a complacent fathering of the new enterprise as the party's own particular bantling and property, with encouraging exhortations, not to be afraid of nasty people who throw stones at, and say disagreeable things about the bantling, but to trust to, and lean upon the party, and all will go well.

It is puzzling to an outsider to see just exactly what the Dominion Coal Co. has to do with either party, in the way of being dependent upon it.

Mr. Fielding, on behalf of the Province of Nova Scotia, made what is generally conceded to be a favorable business arrangemeut with Mr. Whitney and his associates, but we do not conceive that it was a part of the bargain that the Dominion Coal Company should become a subservient attachment to Mr. Fielding's political machine. The astute little premier of Nova Scotia is deserving of all credit for having made a good bargain. It is one that the Conservatives would, no doubt, have readily made had they happened to be the "ins," but since, unfortunately for them, they were the "outs" at the time, they feel sore about it and can see nothing but evil in the whole business.

It appears to us that politicians in Nova Scotia, who apparently number about nine-tenths of the population, have conceived altogether erroneous ideas as to the Dominion Coal Company's objects and destiny in Cape Breton, and the sooner they grasp and digest the notion that the company is an ordinary commercial undertaking, whose primary and prevailing object in calling it into existence was to make money, the sooner shall we be spared the reading of very nonsensical paragraphs and letters, whether directed against or in defence of the company, in the local press.

We learn that in spite of a somewhat late and slow start, the output of coal has, so far, been considerably in excess of the quantity put out up to the same period last year, the only falling off being from Cow Bay. This increase is shared in by the General Mining Association, the only company not controlled by the syndicate, whose collieries of Old Sydney mines and Victoria, have been doing a good business. Operations at the Dominion Coal Company's collieries have, as before stated, been carried on pretty much upon the old lines, the only observable change being the centralizing of the management at Glace Bay, where the popular resident manager, Mr. David McKeen, M.P., resides, and whence he directs the net-work of collieries lying around him with a youthful energy which excites the envy and admiration of his friends and subordinates. Meantime, works of development are by no means lost sight of. The Louisburg railway is under construction, half the distance being actually contracted for. The question of providing better and increased shipping facilities in Sydney harbour is one that is engaging the earnest consideration of the management, and the opening of navigation in 1894 will doubtless see the company equipped with a wharf which will enable them to compete with any coal shipping concern on this continent in giving prompt despatch to vessels.

A new locomotive, the "H. M. Whitney"—(a replica of the famous "Sir Donald," built by the Rhode Island Locomotive Works for the late International Coal Company), weighing 60 tons, and capable of hauling 600 tons of coal at a trip with ease, has just recently been added to the rolling stock, and 100 new 10 ton coal hoppers are now arriving by instalments from the Rhodes & Curry Works at Amherst, so that the opening of another shipping season will find the company well provided with rolling stock wherewith to feed their new wharf. An increase in the output of coal will probably be brought about by a development of the Old Bridgeport area, on which it is in contemplation to sink a new shaft. The erection of shops for machine work of all kinds at Glace Bay is also under consideration, and altogether, the Dominion Coal Company, without going ahead with that frenzied haste expected of them in some quarters, is giving substantial evidence of a vigorous policy, not evincing the slightest disposition to ruin the country by closing down the mines or to injure it in any other way. That they ever desired or intended to do so, no sane person can really have imagined, but political exigencies are sometimes responsible for wild and foolish ideas. Having been pretty roughly handled at the outset, and peppered at by skirmishers all along the line since its march began, we hope they may now be allowed to continue on their way unmolested, until such a time as they may give evidence of those cruel and evil intentions which have been so freely imputed to them.

Lightning in a Nova Scotia Mine.

A recent experience in Nova Scotia serves to repeat the saying, "that a miner's lot, like the policeman's, is not always a happy one." Westville, in Pictou County, was recently visited by an unusually heavy thunderstorm. First the office of the Intercolonial Coal Company was struck and seriously damaged, the inmates, fortunately, escaping injury. A few moments after it was found that the lightning had hastened underground by the Scott shaft, a few yards from the office. The lightning appeared to have struck the pulley wheels, some forty feet above the ground, and to have travelled down the wire rope, on to the iron sheets at the pit bottom, and thence into the workings by the rails. Here at some point the sparks found gas and ignited it. There are on record several cases of lightning having descended the shafts of coal mines, and then traversing the workings by the haulage ropes, rails, etc. Rude shocks have been felt by the workmen along the track of the unwelcome visitor; sparks have been noticed, etc., but it is not, it is believed, on record that lives have been lost or gas ignited.

In this case there was a somewhat violent explosion sufficient to derange the ventilating appliances. As the explosion was followed by smoke, it was apprehended that it had ignited the coal, and steps were at once taken to close the openings of the mine. At present the air is excluded so that if any fire exists it may be extinguished for want of oxygen. The pit had been idle for some time, and presumably gas had accumulated.

If the pit had been working with its complement of miners, presumably the danger of an explosion in this case would have been slight, as very great attention has always been paid by the management to its ventilation. Still, as in many mines, especially those of considerable extent, there are old workings and falls liable to accumulate gas, it can be readily imagined that the lightning's erratic course might encounter gas enough to cause disaster. Fortunately this accident occurred in daylight, and prompt steps could be taken to protect the workings, and it is to be trusted that the experience gained may be of service to the mining world.

The erection of lightning rods would at first sight appear to promise a safeguard, but there would generally be a difficulty about collieries in providing a proper earth, and again, the presence so close to the conductor of the large rope, leading generally to a close connection with a water lodgment at the bottom of the shaft, the wire guides for the cage, etc., might neutralise its good effects even if it were provided with a gilt tip. Experience bearing on these points, and possibly of great interest, might have been secured in this case had it been possible to have examined the pit shortly after the explosion.

The point of contact of lightning with the earth appears often to be decided on grounds other than of the presence of large masses of iron. Cases are not infrequent where lightening has struck within a few yards of pits, engine houses, boilers, etc., without apparently displaying a preference for them. It might be found that the most efficacious method of protecting similar plants, would be the erection of a conductor in their near vicinity, rather than at such points as an engine house, pit head, etc. Electricians have here a field to exercise their ingenuity, and no doubt colliery owners would readily pay for any effective means of guarding against so formidable a visitor.

Mining Machinery at the World's Fair.

In commencing a review of the mining machinery at the World's Columbian Exposition, it may be well to state at the outset that the exhibit is not remarkable for novelty or unusual merit. There are many creditable individual displays but they are composed chiefly of standard machinery with which most are familiar.

The most complete single display is that of Fraser & Chalmers (Union and Fulton Sts., Chicago). The most noticable single item and the one which attracts the most attention is a mine pumping engine fitted with the Riedler water valves and valve gear. The machine is of 30 in. stroke with differential water plungers 6 and 8 inches diameter respectively, and is regularly driven at the astonishing speed for this class of machinery of 75 turns per minute. Of course it has no head of water against it, its only work being to pump from a tank to its dicharge pipe, which in turn empties the water back again into the tank, and it is impossible to say how the machine would work under a heavy lift from its action under the above circumstances, but it is only fair to say that running as it now does it is absolutely quiet. The machine is of the duplex pattern, driven by a pair of Corliss engines, somewhat similar to the standard construction of duplex air Compressors, and is in every way a most creditable appearing machine.

Of the standard styles of machinery and appliances in this exhibit should be noted a 9 x 15 crusher of the Blake type, a pair of Eckarts fine crushing rolls of the latest and most improved pattern, the size being 26 inches diameter by 15 inches face; a link motion single drum double cylinder hoist, the drum being 30 inches by 42, fitted to operate a cage hoist which descends through the floor where it connects with the track of a typical mine drift, which extends across and below the Manufacturer's Building and of which more later; a single cylinder single drum hoist arranged with a belt pulley for driving other machinery and intended chiefly for preliminary work; a Morel ball pulverizer, in appearance somewhat like a Crawford mill; a complete 42 in. x 120 in. water jacket lead furnace with a complete equipment of slag pots and all accessories; a Chilean mill with 8 ft. rolls weighing 8½ tons each; screens of various patterns built up and otherwise; mortars wet, dry, and sectional for mule back transportation; retort and bullion furnace; Huntington mill, connected to a 6 ft. frue vanner; a complete five stamp quartz mill, connected with two 4 ft. frue vanners, the wearing parts of the mill being of ferro alumina, and last but not least, two Bridgeman samplers which to us at least are novelties. The larger of the two has a capacity for passing twenty tons of mineral per hour, and taking therefrom as a sample, various portions ranging between 1/32 and 1/128 part depending upon adjustment. This machine acts upon the principle of taking the entire stream a fraction of the time for the sample and it consists of a number of revolving rings, arranged one above the other and revolving at different speeds. These rings contain shutes occuping a portion of their circumference. The upper ring revolves so as to bring its chute from time to time below the chute from the ore bin. The stream of ore flowing from the bin chute through the ring chute constitutes the first sampling, the ore, when the ring chute is away from the bin chute, passing from the sampler at once. In a similar way the second ring takes a sample from the first sample, and so on in succession. The entire machine is very compact and mechanical in construction and appeared well adapted to its purpose.

Next to the exhibit of Fraser & Chalmers, across one of the transverse aisles is the exhibit of the Rand Drill Co., and removed a sufficient distance to prevent active hostilities and to render the intervening ground safe to the visitor, is the exhibit of the Ingersoll Sergeant Drill Co. Each company shows a line of drills mounted in various ways as well as compressors, the exhibit of these machines by the Rand Co. being the largest and most complete. The Rand exhibit comprises both Little Giant and Slugger drills, the latter in one case fitted with the "Derby" bit, which is probably a novelty to most of your readers. It is a star shaped bit attached to the end of a piece of hydraulic piping, which in turn fits into the usual chuck. The piston rod of the drill has a hole through it which has a connection with the upper head of the machine, through which a constant stream of water or air is supplied to the bottom of the hole, where it washes away the cuttings as fast as formed, giving always a clean bottom for the bit to work on and preventing clogging of the bit and consequent delays from accumulation of mud. The shape of the bit is such as to pass seams and other irregularities in the rock without the delays which occur with the usual style. Included in the display are compressors of the straight line, duplex water power, and duplex steam power types, the largest of the latter, a 14 x 22, being shown at work. There is also included a vertical three stage compressor for pressures up to 4,000 lbs. to the square inch.

The display of the Ingersoll Co., includes drills of various sizes and mountings, bar and track channelling machines, gadder, coal cutters and a 16 x 18 straight line piston inlet compressor at work.

Both the Rand and Ingersoll companies have an additional exhibit in Machinery Hall of large duplex compressors. The Ingersoll machine has compound steam cylinders and piston inlet air cylinders. The Rand has both steam and and air cylinders compounded, the latter being fitted with their mechanical valve gear and having an intercooler between the low and high pressure cylinders. Both machines are fitted with Corliss steam valve gear and are shown at work, the air made by them being used throughout the exhibition grounds for various purposes. In connection with them is a number of Norwalk compressors of the standard type, also in motion compressing air for the same purpose.

Adjoining the Rand exhibits is that of P. H. and F. M. Roots, (Connersville, Ind.) who shows a line of their positive blowers and gas exhausters. There is a number seven blower coupled with a vertical engine on the same bed plate intended for foundry use, and having a capacity of 23 tons of iron per hour, and a No. 6 high pressure blower also with engine upon the same bed plate and capable of sustaining a pressure of 12 lbs. per square inch. The gas exhauster has a capacity of 62,000 cub. ft. of gas per hour. It is fitted with direct connected vertical engine and has a beautiful automatic regulator for controlling the speed in order to maintain a constant vacuum in the retort regardless of the quantity of gas delivered. It is also provided with a by pass valve for use in case of failure of the exhauster. We are informed that the Montreal gas light company is provided with a full equipment of these exhausters. This exhibit also includes a small working model of their pneumatic slack and culm conveyor for coal mines, and a rotary pump having a capacity of 4,000 gal. of water per minute.

Adjoining the Root's blower exhibit is a space occupied by the Chicago Iron Works, the chief item of the exhibit being a superb 400 h. p. 20x48 Corliss hoisting engine. The engine is fitted with two flat rope reels, arranged for use either balanced or independent, it being possible to hoist with one reel while the other is lowering, by means of the brake, or one reel may be used for hoisting from various levels, while the other manipulates a bucket or kibble for shaft sinking and pumping. The engine has no friction clutch, but, instead, is fitted with Unzicker's positive claw clutch, this clutch being operated by a steam cylinder fitted with cataract. Each reel is fitted with a large dial indicator having two pointers, the second of which comes into action when the load is within about 100 feet of the surface. It moves at a much higher speed than the usual pointer and enables the load to be landed with greater accuracy. Steam brakes are provided for each reel as well as a safety device to prevent overwinding, this device closing both steam and exhaust pipes, and putting on the steam brakes. The link motion is also operated by a steam cylinder. Those accustomed to the more rough and ready character of customary mining machinery will perhaps criticise this highly organized machine as being an unnecessary piece of refinement, especially for one of its size, but the entire machine is worked out with an obvious painstaking in design and excellent workmanship, which bespeak its successful operation. It is by long odds the finest hoist on exhibition. This exhibit includes also a number of other items including a Chilean mill with three 44-inch rolls, two hydraulic giants, triumph concentrators, stamp mill, mortors, positive blowers, Hartz & Collom jigs, a steel jacket smelting furnace 33 x 84 inch, rolls, crushers, small hoists, etc. They also show what appears to be an excellent arrangement of screens in sets, the arrangement being the opposite from the customary one. The material is put into the *coarse* screen first, that which refuses to pass it being chuted to the proper bin, and that which does pass it being sent to the second screen where the operation is repeated. In this way the finer screens are saved from the destructive wear due to their being obliged to handle the entire bulk of material as with the usual arrangement.

Following this exhibit comes that of the M. C. Bullock Manufacturing Co., (1170 Lake Street, Chicago), who display seven sizes and styles of diamond drills for surface and underground work, together with hoisting engines fitted with the well-known Lane friction drum. Among their diamond drills is one which has a record of having drilled three holes of a depth of 2,026, 2,400 and 2,460 feet respectively; these being the deepest diamond drill holes in America, and so far as known, in the world.

Proceeding north we come next to the American Mining and Milling Machinery Co. (Cleveland, Ohio), who show a crusher and mill for pulverizing. The crusher is extremely compact, due to the fact that the jaw is driven directly from the eccentric without any intervening toggle joint.

Adjoining the above exhibit is that of the Gates Iron Works, who show a giant among crushers, with a capacity of 150 tons per hour to 2½ inches. They also show a set of Cornish rolls, and a complete working model of a ballast making plant with crusher, screens, storage bins, distributing car, etc.

In the same section is the exhibit of the Webster, Camp & Lane Machine Co. (Akron, Ohio), who show a double drum first motion hoist, with slide valve engine 20 x 42, and fitted with Lane's friction. They also show a smaller geared hoist with boiler and overhead works for a small shaft of iron. In the same exhibit is also a motive power Corliss engine 20 x 42.

Near the above is the Prospecting Mining and Machinery Co., (Portland, Oregon), who show the Tremain steam stamp, which is a duplex machine built of iron extremely compact and working extremely well. This two stamp machine is claimed to be equal to a regular five stamp mill, and to be smaller, easier of transport, and in every way more desirable.

Across the aisle and still going northward is the exhibit of the H. W. Johns Asbestos Co., (New York), whose exhibit attracts a large amount of attention. They show a large line of asbestos goods, including fine decorated cloth, similar to theatre curtains, and one is surprised at the list of theatres which the attendant showed him as having been fitted out with these curtains. The most attractive portion of this exhibit, however, is the display of machinery for making asbestos cloth, including carding machine and loom, which are shown at work. The carding machine is very similar to that used for wool, the chief difference being in the cards, which are composed of No. 32 wire instead of 27 or 28, which are used for wool. The loom is very similar to a cotton loom, but heavier and run at a much slower speed. The spinning is not shown, but your correspondent is informed that it is done upon a mule. There is also shown a braiding machine for use in making asbestos packing, also specimens of asbestos rope which have been broken in a testing machine to determine the strength of the rope. The test was made both dry and after prolonged soaking in water. The dry rope showed a strength of 4,400 lbs., and the wet rope of 1,800 lbs.—the size being one inch.

In this connection should be mentioned the exhibit of our friend Mr. L. Wertheim, (Frankfort, Germany), of asbestos goods of all kinds in Machinery Hall. This exhibit of manufactured asbestos goods is the most extensive in the exhibition and includes a full suit of asbestos cloth mounted upon a clothier's dummy. It also includes a toy theatre with the scenery painted on asbestos cloth, and fitted out with gas jets playing upon the scenery to demonstrate its fire-proof character.

Next in order comes the Bradley Fertilizer Co., (92 State St., Boston), who show the Griffin mill in three sizes. (Manufactured in Canada by the Jenckes Machine Co.) These machines are connected with power so as to be shown in motion to illustrate their very peculiar action. The exhibitors, however, have respect for the ears and nerves of visitors and show the mills in action only when requested to do so.

Near the Bradley Co. is the Mechanical Gold Extractor Co., (47 Broadway, New York) who show the Crawford mill both full size and by a working model.

Following them is the Steam Stone Cutter Co., (Rutland, Vermont), who show the Wardwell Channeller, both the old style or drop type for vertical channelling, and the new or universal type for angle channelling.

Near them is the Sullivan Machinery Co., (Claremont, N.H.), who show seven sizes of diamond drills and two styles of channelling machines—the sandstone machine for vertical work and the marble machine for universal work. The first of these is in very extensive use on that immense work, the Chicago drainage canal, which is to be 160 miles long, 120 feet wide and 30 feet deep—a genuine artificial river. About fourteen miles of this work is through solid rock and the sides of the excavation are being channeled by the Sullivan Company's machines. If a section of this canal could be transported to the exhibition grounds, it would form one of the most interesting exhibits there.

The Sullivan Company also show a considerable line of coal mining machinery, including the Stanley entry driving machine which, however, retains the inventor's mechanism only in the cutter bar. The most marked change is the entire abandonment of track and wheel for carrying the machine. In their stead appears a simple shield of boiler iron which slides upon the surface made by the cutter bar. The machine is thus capable of continuous action without any delays from track laying. The machine is also fitted with a new feature consisting of a conveyor for carrying the cuttings away from the machine to the car. The coal mining machinery shown here comprises coal cutters of the cutter bar type for both room and pillar and long-wall systems of mining. They also show a gadding machine for marble quarries.

In coal cutting machines there is also an extensive exhibit by the Jeffrey Manufacturing Co., (Columbus, O.) who show the well known Jeffrey Mining machine both electric and compressed air, and fitted for work. They have a large mass representing a make-believe coal seam, constructed of the universal and protean staff, with the coal machines arranged for running under it, thus illustrating very clearly the method of operating. One of their cutters is mounted upon a truck to the wheels of which its motor is geared so as to act as a self propeller. The wires are strung along the roof of the entry and approximately parallel. The trolley has double wheels for contact with the two wires, and is taken in the workman's hand and held in contact with the wires, the workman following the machine on foot. Of coal mining machinery they also show coal drills, both electric, compressed air and hand power. They likewise show a rotary electric pump mounted on truck, and provided with suction and discharge hose for portable use about the mine. In the same exhibit is a line of link belt elevators and conveyors of various patterns in connection with screens for a variety of uses.

In immediate proximity to the last named exhibit, is one by the Nelsonville Foundry and Machine Co. (Nelsonville, O.), the chief item of which is an excellent double cylinder double drum geared friction hoist, which of its class is the finest on exhibition.

Several foreign exhibitors show mining machinery in connection with their other exhibits in Machinery Hall. Among these are the Rio Tinto rock drill, which is exhibited by a gentleman whose method of explaining the numerous claims of his machine would excite the envy of any Yankee rock drill salesman, and unlike some others that we have seen he really seems to believe all that he said. Near by in the same building is the Daw drill, now famous in the annals of our General Mining Association of Quebec.

The chief exhibit of mining machinery in Machinery Hall is, however, that of the great Fried Krupp, Grusonwerk, (Machinery Hall, Columbian Exposition.) The first item noticed in this exhibit, is a rock crusher of the Blake type with steam engine attached. This machine is constructed with all of its chief parts of steel, and sectionalized for mule back transportation, the heaviest piece weighing 300 lbs. The size of the crusher is 16 x 10 inches. The workmanship and construction upon this machine, which is shown in operation, like that of all the Krupp exhibits is of the most superior character. The fly wheels of the crusher are made with hollow rims, in order to save heavy pices in transportation, the intention being that the hollow spaces shall be filled with lead after the machine is set up. Another machine in the exhibit is a worm mill, for the mixing and coarse grinding of various ingredients for the manufacture of Portland cement, and similar work, and along side of it is another machine for mixing materials in fixed proportion according to adjustment, the materials being taken by the machine from suitable hoppers. The machine shown is adapted for the mixing of two ingredients only, but they are made for the mixing of any number of ingredients, and the extremely courteous and obliging attendant assured me that the machine was extremely accurate in maintaining a proper proportion of the ingredients. This machine like the preceding one is largely composed of steel and chilled iron.

The largest and most striking item of display is a Chilean mill, with rolls two meters diameter, twenty centimeters face, and weighing twelve thousand lbs. each, the tyres being of cast steel.

A novelty in this machine is in the construc- of the crank axle, the crank pins being set at an angle of six degrees less than a right angle with the cranks. In other words, the plane of the wheels is not tangent to the track in the mortar, but the wheels look inward in the direction of the motion, thereby obviating the constant pull of the wheels upon their journal, due to their tendency to follow a tangent to their circular track. This machine like all the others in the exhibit shows a degree of care and refinement in the design, workmanship and finish, which seems almost sacrilegious in machinery intended for such purposes.

To us, however, the most interesting item of the exhibit, was a number of ball mills. We have seen ball mills before and likewise foundry rumblers, but these machines are of a very different order of architecture. The largest of the lot has a drum 8 inches diameter, lined with steel plates, and intended to carry 1900 lbs. of steel balls 4 to 5 inches diameter. The machine is continuous in its operation, the feed being through the center and automatic, and the discharge being through a spout at the bottom of a boiler iron case which surrounds and encloses the entire machine. The machine is fitted with screens so that all of the material discharged is pulverized to the required degree of fineness, and by a beautiful and unique arrangement the material which refuses to pass the screens, is automatically put back into the mill to be re-ground. This is accomplished by the arrangement of the plates which comprise the circumference of the drum. These plates are arranged with an opening between each pair, this opening being tangential to the circle of the drum. Each plate passes by the other at this opening, so that in the direction in which the machine turns the material within the drum falls from one plate to the next like water on a shingled roof, but the material which passes through the holes provided, is caught upon the screens which travel with the drum, and are provided with ribs which catch the material too coarse for the screens and carry it upwards to the top of the machine, where the plates no longer act like shingles, but allow the material to fall back through the openings discribed. The screen is also protected by a coarser screen within it to save wear. The writer was shown material ground by these mills to pass through a screen of 200 meshes to the inch., and the work seemed perfect. The mill is said to be in very extensive use in Germany, 16 being in use at one cement works, where the entire set is attended by two men, all of which would indicate that a knowledge of the art of saving labour is not confined to New England.

There is also shown in this exhibit, a concentrating plant for fine ores and slimes, consisting of hydraulic classification machines, jigs and percussion tables, all upon the Bilbarz system.

Entirely without the buildings with one terminal at the mining building directly over the extremity of the Fraser & Chalmers' mine level, and with the other at the western boundary of the exhibition grounds, is a complete wire rope tramway by the Trenton Iron Co., and of their Bleichert system. This is in every respect a full working tramway, its length being about 1,000 feet, and its capacity 20 tons per hour. It has four intermediate supports between the terminal stations, built of iron in the most substantial manner, two of them being 40 feet high, and conducting the tramway over the intramural elevated passenger railway. The tramway is driven by a Thomson-Houston five-horse power electric motor. Our readers are no doubt acquainted with the Bleichert system, and it will be unnecessary to do more than give a general description of it. It is of the double rope type, the main or carrying cable being of the locked coil construction, and the smaller, or driving cable, of the usual pattern of wire rope. The line is equipped with a full outfit of ore buckets, with switches and turnouts for the full and empty cars at the terminal stations, together with a lowering device for dropping the loads to the mine cars of the Fraser & Chalmers' drift. The tramway is in daily use transporting the diamondiferous blue ground of the DeBeers Mining Co. of South Africa, who have a large quantity of this diamond-bearing rock stored at the further terminal of the tramway, where it is guarded by a force of Zulu warriors. This rock is transported across the exhibition grounds by means of the tramway which drops it into one of the Fraser and Chalmers' mine cars. In this car it is carried across and below the mining building, where it is hoisted by a cage hoist to the level of the floor, in the middle of the Fraser & Chalmer's exhibit. It is here put through two crushes, coarse and fine, and is then carried to the main exhibit of the DeBeers Mining Co., in connection with that of Tiffinay & Co., of New York, in the center of the Mining Building. Here is shown the complete process of washing, sorting and cutting diamonds. This exhibit, as may well be imagined, forms one of the most attractive in the entire exhibition, and is constantly surrounded by an eager throng of sight-seers. The separation process is extremely simple, and consists first in the thorough incorporation of a certain amount of water with the crushed rock. The mixture is then put through a simple jigging process for the complete removal of the finer particles, leaving behind only the clean broken rock with the diamonds distributed through it. The jigs have, however, a conveyer ar-arranged in the over-flow trough, which carries any of the coarser particles or diamonds which may accidentally be washed over, to an elevator, which carries them back again to the jigs. The actual separation of the diamonds is performed by hand, upon an iron table, over which the crushed material is spread thinly by a tool provided for that purpose. The rough diamonds are much less rough than popular opinion makes them, and their selection is attended with no uncertainty, except that growing out of the extreme monotony of the work. This causes an occasional diamond to be overlooked, and the whole material is therefore gone over a second time and by a different man. The labor employed at the mine is entirely native, with white overseers, and the most elaborate precautions are taken to prevent pilfering by the men employed. These precautions are largely assisted by the laws of the District, which make it a criminal offence for any one to have in his possession an uncut diamond for which he cannot give a proper accounting. The white men who pick out the diamonds are not included in these stringent regulations of the general labor, but they are, however, under heavy bonds. It is proper to add that the crushing process is not employed at the mines. The diamond-bearing rock has the very convenient property of disintigrating when exposed to the weather, and the rock is exposed for a period of about eight months, upon levelled and prepared pieces of ground for that purpose. The crushing process is employed here to expedite the work, and at the expense of an occasional chipped stone. The Tiffinay exhibit in connection with that of the DeBeers Co., shows the entire process of chipping and polishing the stones, there being four lapidary's wheels at work. The value of the diamonds shown aggregates three-quarters of a million dollars, and with them is a collection of specimens of the blue ground with the diamonds exposed in the fractures.

The yield of diamonds averages about one and one-quarter carets for each cubic yard of rock, although, of course, the ore shipped to the exhibition, is much richer than this. We were fortunate enough to see two diamonds discovered from the mass of broken rock upon the table.

It would not be proper to conclude this article without a notice of the really superb models of mining operations which are shown in various parts of the mining building. In the Pennsylvania section is a complete model anthracite coal breaker by the Philadelphia and Reading Coal and Iron Co., having an entire length of 24 feet. This model illustrates both slope and shaft work —for it must be remembered that in Pennsylvania nothing is a shaft which does not descend vertically in the earth. Underground wire rope haulage is also shown in this model, together with a section of an ideal anthracite mine. The entire model is a working one, all the operations being performed by model engines which are driven by compressed air from the general compressed air supply, already described.

In the Michigan exhibit are several almost equally interesting working models. Among them is an automatic dump skip and balance car, which illustrates an existing plant at the Central copper mine. This is upon a system which has become quite popular in Northern Michigan, by which the skip is balanced by a dummy car, running down an old and disused incline, the skip itself being in a vertical shaft. By this system nearly all of the advantages of balance cages in pairs are secured, excepting of course, that the output is not as large as with double cages. At the same time the expense of the larger shaft is saved.

Near the above is a model of about 10 feet square, showing the combined rock and shaft house at the famous Tamarack shaft. This is a vertical three compartment shaft three thousand feet deep, worked by a balanced Allis engine, one of the finest upon the entire peninusula of Michigan. Two of the compartments are employed for hoisting, and the third for pumping and lowering of timber. Along side of this model are others from the Calumet and Hecla, one being a shaft and rock house, similar to the above but connected with an incline shaft which is shown in section to the depth of the first level, where is shown a typical Calumet and Hecla arrangement of ladder ways, tracks, etc., for the handling of the ore. The other Calumet and Hecla models show the stamp mill of the Company, one being the old mill fitted with Ball stamps, and the other the new mill with the modern giant Leavitt stamps, together with the jigs and slime tables belonging thereto.

One of the best models in the exhibition, is that of the H. C. Frick Coke Co., which is located in the gallery of the Mining Building. It comprises two complete shaft houses, one for vertical shaft, and the other for slope work, the latter being shown in connection with a set of coke ovens complete with charging cars, etc. The ovens are fitted with burning gas jets to add to the realistic effect. The vertical shaft house has a model shaft descending through the floor, and fitted with a complete balanced cage hoist.

The model of the Gates Iron Works, showing a complete ballast making plant, has already been described.

There are a few pieces of mining machinery of which we were unable to obtain information, owing to the absence of any attendant. This is especially true of the foreign department. The chief item of this description, was a large size buddle table in the German department which had no attendant, but referred inquirers to the Commissioner of the German department. Repeated attempts, however, failed to obtain any circulars or other information. It passes comprehension to understand how foreign exhibitors can go to the heavy expense of making exhibits, and then leave them in this condition.

EN PASSANT.

Dr. C. LeNeve Foster, in a recent paper, offers a few suggestions for improving the mineral statistics presented in government reports on both sides of the Atlantic. In Canada there is great need for reform in this regard. At the present time the reports from the Division of Mineral Statistics and Mines in connection with our Geological Survey are issued altogether too late to be of any practical service to the mineral operator; while the lack of uniformity and completeness in their compilation when published is so apparent as to render them absolutely unreliable. We venture to say that no one in this country, with a knowledge of its mineral development regards these reports as a faithful picture of the state of our mining industries. Indeed the opinion is unanimous throughout the mining men of the country that this branch of the public service requires a thorough overhauling. We are quite aware that many difficulties hamper the work of the officer in charge, but be the responsibility where it may, it is high time that the Hon. the Minister of the Interior, or Dr. Selwyn, made some well directed and energetic move to publish these statistical reports earlier and in a more thorough and reliable form than at present. Dr. Foster calls attention to the many differences in method of making out government statistics, and strongly urges uniformity, or that the different governments shall at least add to their several reports one general complete table based on a uniform method of weights, measures and classification.

Until Congress decides what is to be done with the Sherman Act, the silver question is certain to remain chaotic, with more or less violent fluctuation in the value of the metal. Silver producers all over the world have begun to set their houses in order. They perceive the signs of the time are adverse and recognize that the repeal of the Sherman Act will take away the legislative prop which has so long kept their product at a false level. In the United States, which produces some 55,000,000 oz. of silver annually—or about one-third of the total quantity raised in the world—nearly the whole has been purchased by the United States Treasury, hence it is not surprising to find that the mines in Colorado, Nevada, Utah and Idaho, are all closing down. In Mexico the output is being restricted. It is being practically stopped in Peru and Chili, and in Australia, even the great Broken Hill mines are shutting down. This means that the great majority of the mines cannot raise silver at anything like the present price, and it means, further, that the law of supply and demand is at last to be allowed to have unfettered operation. As prices rise again the better mines will come into the field afresh, and —unless unwise action should be taken by any of the Governments concerned—we may expect to witness a far healthier state of things than has existed for some years past. Under any circumstances a large amount of silver will be needed for currency purposes in India, China, South America, and all the silver-using parts of the world; but there will be no longer any avalanche hanging over the market—that is to say, if the United States Government decide to act cautiously with their stock; and it is highly probable that exchange with India, etc., will improve and remain steadier, with excellent results upon our trade with the silver-using countries. A side issue of some moment to our readers in the great argentiferous galena country now opening up in British Columbia is that which relates to the price of lead. As is, or should be, well known to them, a very large proportion of the silver raised in the United States and elsewhere has been obtained from argentiferous lead ores. The lead has been got and smelted for the sake of its silver contents, the lead itself being treated as a sort of by-product. Henceforth this state of affairs will not exist. It will not pay to get the silver at present prices; consequently many of the mines in the Leadville district are being closed, and the reasonable inference is that the output of lead will be greatly restricted so long as existing conditions prevail. Inferentially, therefore, lead should improve in price before long. Any marked advance in values would enable many of our own lead mines to be worked at a profit, so that indirectly the latest phase of the silver question may have an important bearing upon our Canadian mining industries.

About two years ago Messrs. W. H. Greene and W. H. Wahl, were induced to undertake the search for a process for the production of manganese free from carbon upon a commercial scale. The results of their experiments are described in the Journal of the Franklin Institute. Starting from ordinary manganese ore, they found that nearly all the iron can be removed from pyrolusite, by digesting it with diluted (30 per cent.) sulphuric acid near the boiling point, ferrous sulphate being formed while the manganese peroxide is pratically unattacked. By this means the iron in a manganese ore, may in a few hours be reduced from 5 or 6 per cent. to a few tenths per cent., with a loss of manganese not exceeding 1 per cent., while the copperas that may be obtained by the treatment of the waste acid with scrap iron will pay the cost of the purification of the ore.

Numerous experiments upon the reduction of the ore by carbon have led the authors to the conclusion that it is impossible by a combination of methods to obtain a metal with less than 6 per cent. of carbon, and that it is equally impossible to remove the carbon so combined by fusion with oxidizing agents. The reason of this is seen in the results of some experiments lately published by Guntz, who finds that manganese is rapidly oxidized by carbonic oxide at a red heat with the production of manganous oxide and carbon. It will, therefore, be readily understood why pure manganese cannot be made either in the electric furnace or in graphite crucibles.

After many trials of electrolytic methods depending upon the use of baths of molten fluorides which led to no result, a method of reducing manganous oxide by aluminium has been worked out with complete success. This includes two operations; in the first the purified peroxide by exposure to the action of reducing gases at nearly a red heat is reduced to manganous oxide, a greenish grey substance which must be cooled out of contact with air to prevent its oxidation to Mn_3O_4. The monoxide is then mixed with about 18 per cent. of granulated aluminium and a suitable flux, which may be either siliceous or a mixture of lime and fluorides, and heated nearly to the melting point of cast iron in a magnesia crucible. As soon as the temperature of reaction is attained the mass fuses, and must be poured from the crucible while at its maximum temperature. The character of the flux has but little influence on the reaction, but indirectly it has an important relation to the yield and quality of the metal. If it is siliceous there will be some silicon reduced, and if it is too fusible, part of the aluminium may float up to the surface and become ineffective for the reduction. The best mixture has been found to be lime and fluor spar. Theoretically, one part of aluminium should reduce three parts of manganese ($3MnO + 2Al = 3Mn + Al_2O_3$), and working in crucibles on a small scale producing several pounds of manganese at one operation, the best result obtained has been 2·8 parts, corresponding to a reduction of 97 per cent., while the average yield has been 87 per cent. With aluminium at its present price, the authors therefore consider that manganese metal, with 1 to 2 per cent. of iron and silicon and free from carbon, may be prduced at less than 1s. 6d. per lb., this estimate including all expenses.

On the large scale it is proposed to conduct the operation in a reverberatory furnace with a magnesia lining, with a slight excess of reducing gases in the flame, which it is believed will retain the ore in the condition of lowest oxidation until the temperature of reaction is reached, when the prompt fusion of the flux will protect the reduced metal from contamination by carbon in the flame.

Having experienced a considerable difficulty in the preparation of magnesia crucibles, the authors adopted the expedient of lining plumbago crucibles with a stiff paste of calcined magnesite. When properly prepared these linings do not crack on drying, nor do they separate from the plumbago walls. They have been found to be very useful not only for the preparation of manganese, but in other metallurgical work where siliceous or plumbago crucibles were from any cause objectionable.

RING DOWN THE CURTAIN!

Misrepresentation, Extravagance, Boodling and Bad Management, Reduce the General Phosphate Corporation Ltd., to Insolvency, and the Great Big White Elephant Lapses into Obscurity "Unwept, Unhonored and Unsung."

To readers of the REVIEW no surprise will be experienced at this announcement. The inception of the Corporation as foreshadowed in the notorious green prospectus in 1889, and the questionable methods adopted in its promotion in the following year by Knud Sando, Mallaby Deeley, and others of that ilk—the enormous prices paid for undeveloped and comparatively worthless areas of mining lands to prominent Canadian politicians, the bluster and swagger and extravagance of its management both in Canada and in London, the revelations in the celebrated case of Stewart v. Wills—in fact the whole history of the ill-starred venture have been commented upon so fully in these columns as to leave no doubt in the minds of our readers as to the ultimate issue. While it is to be regretted that a number of very desirable investors have lost their money, it is more to be deplored that the fair name of the resources of our country should have been dragged in the mud by a parcel of unscrupulous adventurers. The following are the accounts of the last meeting of shareholders and the proceedings in court.

MEETING OF SHAREHOLDERS.

The adjourned meeting of the shareholders, directed to be held by Mr. Justice Vaughan Williams, for the purpose of ascertaining their wishes as to whether an order should be made on a petition, presented by Mr. George Mander Allender, to wind up the company compulsorily, was held at the Cannon Street Hotel, London, last month.

LORD STALBRIDGE, (the chairman), presided, and stated that the meeting was adjourned from the preceding Friday until that day, in order to see whether it would be possible to reconstruct the Company on the basis that the directors and their friends should find £50,000 to carry on the company. The directors and their friends had met and discussed the matter in all its bearings, and they had found it impossible to raise that amount. They could raise about £27,000, but £50,000 was beyond their capabilities. There were also some conditions attached to their lending the £27,000 which might be difficult to carry out, one of which was that all litigation should cease. There was no possibility of that, and, therefore, they must now consider what was best to be done in the interests of the Company.

SIR JAMES WHITEHEAD said a report had been issued by a committee of shareholders of the Corporation, which, more or less threw out insinuations against the directors, and in one instance an action had been brought, not only against the Company, but against the original directors. Under such circumstanccs it was impossible for the old directors to advance money to reconstruct the company. Those allegations must be met, and he, and those associated with him, would do all in their power to bring about a thorough inquiry.

THE CHAIRMAN, after a long discussion, moved: "That the Company be wound up compulsorily."

This was seconded and lost, four voting for and 70 against, which included 49 proxies of the shareholders' committee.

MR. JUSTICE WILLIAMS ORDERS THE CORPORATION TO BE WOUND UP.

On Monday, 25th ulto., Mr. Byrne, Q.C., presented a petition on behalf of G. M. Allender, an original allottee, for the compulsory winding-up of the General Phosphate Corporation. The Company, Mr. Byrne said, had acquired certain phosphate properties, which, if not valueless, were almost so. Practically, no trade has been carried on, no profits had ever been made, and there was no property, except these phosphate properties, to reach which it was preliminarily necessary to construct a railway, and power had been obtained for this purpose. There was uncalled capital of £8 per share, and there were debentures to the amount of over £100,000. Interest, and Mr. Byrne believed capital, was due on the debentures, and there were no assets except the unattainable phosphate properties. The Company was commercially insolvent and could only pay its debts by means of calls. There were shareholders who were trying to get off the list on the ground of fraudulent misrepresentation, and it was probable that they would be successful. It was desirable, therefore, that the matter should be crystallised at once, in order that there should not be further shareholders going off the list at the expense of others.

MR. FAREWELL, Q.C., supported the petition on behalf of debenture holders to the amount of £84,000, and Mr. E. W. Ansell, also supported on behalf of four shareholders.

MR. DUNHAM opposed, representing nearly one-third of the capital. He stated that at a meeting of the Company 70 votes were cast against the compulsory winding-up and 4 in favor, and he protested against the presentation of a petition by a single shareholder against the feeling of the remainder. He argued that the Company could be profitably worked by the setting free of the uncalled capital.

MR. BUCKLEY, Q.C., appeared for the Company, and expressed neutrality as to the result.

MR. JUSTICE WILLIAMS, in giving judgment, said that, in his opinion, he ought to order the Company to be wound-up. Various grounds were relied on in the petition to support the proposition, but they all came to nothing, except the statement in paragraph 12, which said that the properties could not be worked by the Company at a profit, which, coupled with the other allegations in the petition, amounted to an allegation that the whole substratum of the business of the Company was incorporated to carry on had become impossible. There was one material statement, that having regard to the frauds in the promotion of the Company, a compulsory order was necessary to secure due investigation. He was, however, going to base his decision mainly on the ground that the properties could not be worked at a profit, and that in that sense the substratum of the Company was gone. He wished to add that it seemed to him that, in the case of a shareholders' petition not based on insolvency, there was no justice in hastening the winding-up in order that the opportunity of those who had been defrauded into taking shares from getting relief might come to an end. On the evidence before him, it was perfectly plain that the Company could not continue its business, so the only thing for him to determine was what the shape of the winding-up should be. In the circumstances, he thought the order should be a winding-up under the order of the Court, because there were allegations of fraud in the promotion and history of the Company, which allegations, it was plain, were believed by the committee of shareholders who investigated the matter.

MINING NOTES.

[FROM OUR OWN CORRESPONDENTS.]

Nova Scotia.

Caribou.

Mr. George W. Stuart has resigned the management of the Truro Gold Mining Co. at this place. It is understood Mr. Stuart was dissatisfied with the policy of the directors, and declined to withdraw his resignation. The property will be sold in September to effect a reorganization.

It is rumored that the owners of the old Moose River Co., which was so lavishly equipped by Mr. Scott some ten or twelve years ago, are desirous of selling, or effecting some transfer which will enable them to realize upon their investment. Something over $150,000 was expended upon the property.

Killag.

The reports from this district are to the effect that the Stuart lode, worked from the vertical shaft, is showing well. Several trial crushings have been made during the summer, which yielded from one ounce to five ounces per ton. There is no longer any doubt as to the lode being the Stuart lode, nor has the mythical "fault" yet materialized. The shaft still continues wet.

Fifteen Mile Stream.

Recent rumors of a rich strike here, upon investigation, have shown that a wonderfully rich pocket was uncovered, but that the vein as a whole will average about one ounce to the ton. The vein is large and big yields are expected.

Oldham.

The mill of the Oldham Gold Co. (Hardman & Taylor), was broken into on Sunday night the 30th of July, and amalgam and plates to the value of over $700 were taken. The stolen property was traced and the thieves have been tried and sentenced to the penitentiary for three years. Some $500 of the stolen property was recovered. The robbers were two brothers, Alexander and John Greno.

Montagu.

The Symon-Kaye property, represented by Mr. Alfred Woodhouse, of London and Halifax, is in the hands of tributers. No work is doing on company account.

Waverley.

This district is quiet. The East Waverley property (Tunnel Co.) is being quietly developed, and is showing large bodies of quartz.

The West Waverley Gold Co. have added ten more stamps, making twenty stamps dropping for the month of August. The yield for July was larger than usual.

Quebec.

We are informed that developments now going on at the Russell zince-blende mine, on Calumet Island, have recently uncovered a very promising vein of native silver lying on the under side of a large body of zinc-blende, at a depth of 30 ft.

Mr. F. B. Hayes, Ottawa, has a small force at work on his mica property at Lac Pied des Monts, about six miles back of Murray Bay. About three tons of white mica have been taken out at writing.

The Eustis Mining Company continues its usual force at Capelton, and shipping ore goes on briskly.

We regret to learn that the Nichols Chemical Company, who have been working the Albert mines, adjoining the Eustis mine, for several years, have suspended mining work. The Chemical and Fertilize Works, however, are said to be working full time.

The Danville Slate Co. (Messrs. J. N. Greenshields and F. Boas, of Montreal), have acquired the old Danville quarry and for several months have been quarrying with satisfactory results. The slate shown us is of the best quality, and Mr. Greenshields says us there is plenty of it.

Ontario.

The Copper Cliff, Evans, Worthington, Blezard and Murray nickel mines in this district are all working full force, and three of the smelters are kept going night and day, but the Drury mine is still closed down

A Kingston dispatch states that a Pennsylvania company has purchased a quantity of iron ore from the mine at Calebogie. It will be experimented with, and if satisfactory the property will be purchased and operations resumed. Ore has not been shipped from that district for over three years.

British Columbia.

Kaslo District.

The dispute with regard to the Bon Ton and Big Bertha claims, which at first threatened to be seriously prolonged, has been amicably settled on the report of the surveyor, Mr. Ellacott, who made a joint survey of the two claims. Last year in August, men in the employ of Capt. R. C. Adams, of Montreal, discovered and located what they called the Bon Ton claim. Assays of picked samples ran as high as 1,250 oz. silver, and an average of the whole ledge gave 375 oz. The assessment work was completed in October, and after the men had left, the owners of an adjoining claim, the Big Bertha, which had been located three days previous to the Bon Ton, continued work where the Bon Ton people had left off. Working through the winter they drove a tunnel 100 feet on the Bon Ton ledge and sacked the ore that had been previously taken out, as well as what they won themselves, claiming that the ledge was on the Big Bertha. The survey has established that the tunnel is on the Bon Ton and the Crown patent is being applied for.

The Big Bertha had acquired a big reputation and had been bonded for something like $40,000 on the strength of the showing in what was really the Bon Ton ledge. Litigation had commenced, but on Capt. Adams' arrival, a final settlement was amicably made.

Capt. Adams, from Montreal, is one of the Canadians who is investing largely in this district, with full faith in its capabilities and prospects. He and those associated with him (wealthy Boston capitalists), have spent considerable time in the district this summer, and are pushing on their assessment and development work with a view to entering on energetic mining early in the coming year, their object being exclusively to work their properties themselves.

They also have the Chamblet and Britomarte claims in the Mount Adams district (Slocan), where they have eight men at work opening up the claims with a tunnel which is already in about 50 feet. They have a ledge 40 feet wide in places, of good concentrating ore on the Britomarte, while on the Chamblet they have a 3 foot ledge of practically clean galena averaging $1.25 to the ounce of silver per ton. They also own the Landscape claim and other interests in this district. Besides they have the Skylarks Westland and Conundrum, on Kootenay Lake, near Ainsworth, on which the assessment work is to be done this month. They are close to the lake, and their development will be simple and easy.

In the Okonagan country Capt. Adams has eight claims with gold-bearing quartz in the Fairview and Osoyoos districts. Average assays give up to $19.50 in gold, and hand samples have given as much as 289 oz. silver and 11 oz. gold to the ton. He intends making immediate investigations of these properties, and if the results are as favourable as expected, he will prepare to work them next year. The captain, on his return from the Slocan country, is quietly and seriously enthusiastic and says that though there are probably cases where the ore bodies are simply "bunches" and "blow-outs" there are many properties which have been conclusively proved to be continuous and of such an extent as to warrant the claim that the district will be one of the greatest silver producing countries in the world.

The Kootenay and Columbia Prospecting and Mining Company, Ltd., of Ottawa, Ont., has been working the Wellington mine since last August with most satisfactory results. They have had a diamond drill, steam pumps and steam hoist in operation, supplied by steam from a Kelly sectional boiler, and they are now shipping ore to Tacoma. The shipments made by this company from this mine during 1892, showed that the ore was of a very high grade—some of it being the highest shipped from the district, viz., 1,097 oz. silver to the ton, while the average ran 375 oz. The vein is 4 feet wide, 2 feet 6 inches of this being solid ore, galena and grey copper, the other 18 inches being good concentrating ore.

At the present time the ore is being taken from the mine on mule back down a mile and a half trail to their ore house on the waggon road, and from there to Kaslo by waggon. The property is in charge of Mr. Ed. Watts, the company's manager in the district, who has had a lengthened mining experience both in Eastern Canada and in Colorado and the Western States.

In conjunction with a Spokane syndicate the Company is also working the Stanley, which produced 50 tons of ore during June, and are also interested in more than 20 other claims in the Slocan country, on which development is being pushed on rapidly. These properties have lately been visited by Mr. W. A. Allan, of Ottawa, who has expressed himself in the highest terms of praise of the country, and he is confident that it is one of the richest silver-lead districts in the world.

The intention of the Company for this year is to continue their work as at present, opening up and developing their properties until the silver question is more settled, and with the thorough belief in their value they already express their intention of pushingon vigourously the mining of the properties early in the coming year.

The C. P. R. offers to ship ore from Kaslo to Swansea at the rate of $27 per ton in carload lots. The present rates from Kaslo are: to Tacoma $9.50, to Helena $7.50, to Great Falls $7.50, to San Francisco $11.50.

The Kaslo sampler commenced work on August 11th, by putting through some five tons of Bon Ton ore, which gave a result of 375 oz. of silver per ton and 43% lead. The sampler has a Blake crusher, a small Gates crusher and a sampling pulverizer, driven by a 25 h.p. engine and portable boiler. It is well built in a sheltered part of Kaslo Bay, with a good wharf, and is easily reached by both water and road. The Company buy the ore, giving 50 per cent. of the assay value in cash on sampling the ore and the rest when the smelter returns are received. This will be a great help to small mine owners and will enable many men to proceed with their work who would otherwise be compelled to stop from want of funds. The management is in the hands of Mr. Clymo, of Montana.

Development work on the Yosemite claim on Liddle Creek (Slocan), has been pushed with very satisfactory results. The ledge has been found to be continuous for at least 1,500 feet and is in places 11 feet wide, 3 feet being clean galena and the rest good concentrating ore. The galena carries over 150 oz. of silver to the ton.

Steam pumps and hoisting gear are being put in place at the Dardanelles by Mr. Rea Cockle. The mines are in charge of Mr. Davenport (one of the owners), who has had a long experience in mining throughout the Western States. There is a group of seven claims, and shipments of ore made from them have averaged as high as $500 to the ton. The ore is galena.

Vancouver Island.

In the report of the Medical Committee of the New Vancouver Coal Co., submitted at the annual meeting of the employees, held last month, the following abstract of financial statement was submitted :—

Receipts.

To Balance brought forward........	$ 184 00
Northfield Medical Fund.......	418 00
Receipts as per monthly pay roll.	10,403 25
Receipts, Special Levies........	4,608 00
	$15,613 25

Payments.

By Salary of Surgeon..	$ 8,216 10
Northfield Medical Fund.	110 00
Ordinary monthly payment for accidents..................	2,506 00
Special Grants :—	
J. Williams...............	800 00
W. J. Pollard...............	500 00
S. Kenyon.................	500 00
J. Spooner.................	500 00
W. Arbuckle...............	500 00
J. A. Macaloney............	500 06
W. Richardson..............	500 00
S. Woodburn...............	500 00
Printing Rules and Certificates..	17 00
Balance—Cash at bank.........	429 15
In hand.............	35 00
	$15,613 25

The New Vancouver Coal Company's miners have decided to accept the proposed temporary reduction of 20 per cent. on their wages, other workers to submit likewise to reductions varying in their cases from 10 to 20 per cent. It is consequently expected that the Nanaimo coal output will again advance shortly, mine owners being able to meet reduced offers for their fuel.

The Hamilton Powder Works of Northfield have just forwarded three more carloads of black powder and dynamite to West Kootenay for blasting purposes, making 14 carloads already sent thither this summer. The Powder Works are, this year, having an unusually busy time.

The total quantity of British Columbia coal received at the port of San Francisco from 1st January to 31st July this year, is reported to be 280,910 tons.

Salmon and Pend d'Oreille River Districts.

(From the Tribune).

While column after column has been printed regarding mining operations in the Slocan, but few lines have appeared regarding operations in a district within easy distance of Nelson; yet there are almost as many men employed in the one as in the other, and the product of the one least known is gold, a metal that appears to be in great demand at present.

From Waneta, at the mouth of Pend d'Oreille river, to the mouth of the south fork of the Salmon river, a distance of thirty miles, nearly all the ground has been taken up by large and small companies, as well as the good ground on several of the smaller tributary creeks. The Kootenay Hydraulic Company has acquired all the bench ground between Waneta and the mouth of Fifteen-mile creek. This company is now engaged putting in a half mile ditch between Sixteen-mile and Fifteen-mile creeks, the work being done by Brewster & Thomas under contract. The ditch from Fifteen-mile creek to Fifteen-mile bar is completed, and sluicing on the bar will be commenced within two weeks. The company's main ditch will be thirteen miles long, and is about half completed. All the small creeks, like Four-mile, Seven-mile, Twelve-mile, Fifteen-mile and Sixteen-mile, are tapped in order to get a supply of water adequate to carry on operations. The company has over sixty men in its employ.

Between Fifteen-mile creek and the mouth of Salmon river, a distance of three miles, are a number of small operators, all at work making ditches. This ground is known to be good as it was worked in the '60's, when everything used was packed in from Walla Walla.

On Salmon river the Bates Company is finishing a 1¼ mile flume at a point about three miles above the mouth of the river. Next above is the Gorkow Company with sixteen men at work on a 1½ mile ditch. This company has its work so well under way that a clean up will be made by the middle of the month. As an indication of the value of the ground, three yards were sluiced and $16 cleaned up. Above Gorkow's the Wilson Company has six men at work whipsawing lumber for a flume. The next above Wilson's is the Downs Company, then comes the Dunning Company. The latter has just started operations. Above Dunning's are the Mizener boys, who are engaged at both placer and quartz mining. They have two placer claims, one on each side of the river. On the east side of the river they are at work on a ledge that carries ore assaying 400 ounces silver and $28 gold to the ton. They also have men prospecting for them on Lost Creek. Mizener's camp is six miles from the mouth of the river.

Above Mizener's, the Fisher, Raife & Long Company has ground on the east side of the river. The Salmon River Hydraulic Company has taken up a claim on Big creek, which empties into Salmon river from the west 2½ miles above Mizener's, and is prospecting the ground. The next above is the Officer Company. At the mouth of the South Fork the Stewart Company has a claim. Quite a number of prospectors are at work on this creek. Five miles above the south fork is a stream called Sheep creek, on which the Spokane Hydraulic Mining Company has a mile and a half of ground.

Altogether, fully 200 men are either at work for these companies or are engaged in prospecting in what is locally known as the Salmon River country, a country that is directly tributary to Nelson. That they are not at work on barren ground is shown by the fact that Mr. Going tested the ground in probably a hundred different spots, and in no pan did he fail to find colors, but, on the contrary, found from five to twenty-five colors of flake and pinhead gold in each pan. Careful estimates give the value of the ground at from eighteen to twenty-five cents a yard, and the cost of working 2¼ cents. Capital, however, is required to open up the claims, as ditches alone cost from $1,000 to $1,200 a mile.

Miscellaneous.

The Westminster Slate Company sent up a pile driver in tow of the tug Kildonan to their quarters at Jervis Inlet Monday to assist in the construction of a new wharf at the quarry landing. The Kildonan will bring back a cargo of slate for shipment to different parts of the country.

The lessees of the No. 1 mine at Ainsworth will make a trial shipment of forty tons of ore from that mine to the Tacoma smelter. The ore is of four grades, namely, first-class, carbonates, and high grade and second grade concentrates, ten tons each. The first-class ore should go 200 ounces to the ton, the carbonates 120 ounces, the high-grade concentrates 350 ounces, and the second grade 150 ounces. Some twenty men are kept at work, and if a concentrator was only erected on the property, the mine could be worked to advantage even at the present price of silver. As it is, however, the expenses of hand sorting and jigging makes the total so high that there is little left to the lessees. The ore will go out by way of Bonner's Ferry on the "State of Idaho."

CANADIAN COMPANIES.

Similkameen Gold Gravels Exploration Co. has made application for incorporation under the Companies Act, B.C. Head office: Vancouver, B.C. Authorised capital, $100,000, in shares of $25. Directors, Chas. E. Hope, T. R. Morrow and Henry Barwick. The objects of the company are to purchase mining leases of lands or mining claims in British Columbia, and to carry on the business of hydraulic or any other process of mining, etc.

Bell's Asbestos Co., Ltd.—The following circular has been issued by the secretary of Bell's Asbestos Company, Limited: "I am instructed by my directors to inform you that the volume of business of the Company is fully maintained, but in view of the universal depression of trade, they have decided that it is undesirable to declare an interim dividend."

The Provincial Manganese Mining Co. Ltd.—The organization of this company, which has been formed to take over the property formerly owned and operated by the Tennycape Manganese Company in Hants County, N.S., has been organised as follows: D. C. Fraser, M.P., New Glasgow, president; George E. Boak, vice-president; W. F. Jennison, manager; Lewis W. DeBarres; and J. P. Burgess, secretary-treasurer. The property contains some 300 acres, and is situated near Walton. Development has been commenced and shipments will be made at an early date.

The New York Freestone Quarrying Co.—Notice is given by W. H. Tuck, in the Official Gazette, N. B. that unless outstanding liabilities of this company are met within three months after publication he will seize its estate for payment thereof. The company at one time did business in the county of Westmoreland, N.B.

Ogema Silver Mine Co., was sold at public sale at Port Arthur, August 15th. The affairs of the company will be wound up, on account of dissension among the stockholders. The mine, which has not been worked for some time, was bought by J. F. Ruttan, of Port Arthur, for $925.

Newfoundland Mineral Syndicate.—Was registered in London on July 21, with a capital of £5,000, in £1 shares, to acquire a certain license to search for minerals, dated June 15, 1892, granted to R. H. Jones, to pay the expenses incurred by this gentleman in searching for asbestos and other minerals; and to prospect for asbestos and metals of any description. The first directors are: C. W. Bradbeer, H. J. Weston, and H. J. Richards; qualification, £50; remuneration not stated.

LEGAL.

An Interesting Action Against our Old Friend, Mr. D. J. Kennelly.

In the records of the Superior Court, Boston, we find that an action has been entered by Wm. W. Hewitt, attorney-at-law, against D. J. Kennelly, late manager of the Sydney and Louisburg Coal and Railway Co., to recover the sum of $5,150, being unpaid fees for legal services rendered in Boston and New York, in Kennelly's claim for $60,000 against H. M. Whitney *et al*, (of the Dominion Coal Co., Ltd.) The statement of claim shows as follows :—

Fees..............................	$5,000
Retainer..............................	250
	$5,250
By cash on account......	100
Balance due............................	$5,150

Tests of Explosives.

E. Larmoyeux and L. Namur (Annuaire de l' Association des Ingenieurs sortis de l'Ecole de Liege, 5th series, vol. v., pp. 77-120), give the results of an extended series of tests made with various explosives, principally to to determine the influence of temperature and of the length and kind of tamping. The tests were made with several samples of grisoutite, compressed powder, and Favier powder. The tabulated results show the weight of the explosives used, the detonator, and the strength of the explosive as measured by projection and by the lead block. The experiments in the presence of fire-damp and suspended coal dust with these explosives are also tabulated, to show the weight of explosive and detonator, the length of tamping, the amounts of dust and gas present, the temperature and the results. A large number of explosives were also tested by being submitted to a falling weight.

The School of Mines at Madrid.

The Spanish Government has recently devoted much attention to the equipment of a suitable mining school At present the attendance of students is but small. The school itself appears to have an important future before it in view of the well-known mineral richness of the country. F. Toldt in the (Oesterreichische Zeitschrift fur Berg-und Huttenwesen, vol xl., p. 446) describes the course of teaching adopted. The Government devoted £40,000 to the erection of the buildings and to their contents. The course is of three years duration. During the first year the studies include chemistry and assaying, mineralogy, and mechanics; during the second, geology and palaeontology, civil engineering, and metallurgy; and during the third year, mining, metallurgy, and electro-technology. The students must pass through the ordinary course at the polytechnic school before entering the School of Mines. Excursions are made by the students as a part of their course of studies, similar to the mining and metallurgical excursions of the students at the the Royal School of Mines in London.

A Chinese Steel Works.—The plant was recently forwarded to China for a Bessemer steel works. It includes two five ton convertors, with the necessary cupolas, blowing engines, cranes, etc. The entire machinery for a large rail mill has also been sent out, as well as that for a plate and bar mill, together with twenty puddling furnaces. Two large blast furnaces of the Cleveland type, with a capacity of about 100 tons a day, are in course of construction on the slope of the Hamyang Hills, opposite to the city of Hankow. The works will cover about twenty acres.

The Choice of Coarse and Fine Crushing Machinery and Progresses of Ore Treatment.

By A. G. Charleton.*

(*Continued from page 126.*)

Mr. T. A. Rickard in a paper read before the American Institute of Mining Engineers, June, 1891, says:†—"The complete success of the treatment is largely due to the extreme friability of the ore, which renders its pulverization easy, whilst its porosity assists materially in the thorough chlorination of the gold." An enthusiastic writer has spoken of the ore as a sort of snow-drift, which melts in the chlorination vats of the company, into a golden sand, such as might be supposed to have been brought from the bed of the river Poctolus, instead of from the top of an Australian mountain. The extreme richness of the stone hitherto available for treatment in large quantities (the capacity of the works being 1,800 tons per week), the extremely minute state of subdivision of the gold, and the physical peculiarities of the ore above referred to, have all tended to make barrel-chlorination applied in this peculiar way a success, where the stamp-mill had been unsuccessful, and this also accounts in no small degree for successful crushing of the ore with rolls.

Mr. Rickard remarking on the cause of failure when the ore was stamped, says:—"The rock which the battery (25 stamps at Dee Creek) was called upon to crush, averaged 10 ounces per ton, but the contents of the tailings proved of much greater value than the amount of amalgam obtained. This led to a critical examination of the ore at the Sydney Mint." It was found that the bullion was of a fineness hitherto unknown in nature, assaying 99·7 per cent., occasionally 99·8 per cent., of pure gold, the rest being copper with a trace of iron, It is remarkable as being almost entirely free from silver. Dr. Lebius, of the Sydney Mint, considered as a result of numerous experiments, that the iron present was in the form of an oxide, which coated the gold, and so prevented its contact with mercury. In a foot note Mr. Rickard adds: "My own experience with the ores of Gilpin County, Colorado, leads me to believe that this is more frequently the obstacle to successful amalgamation than is usually supposed.

For dealing with free-milling silver ores (carrying less than 6 ounces per ton of white metal) belonging to class 2 as a rule one may employ:—

1. Wet stamping, followed by direct amalgamation in pans or barrels. The ores of this class are limited, only embracing decomposed surface-ores, carbonates, and occasional deposits of argentite, chlorides, chlorobromides, and native silver.

For dealing with pyritic ores of gold and silver, belonging to class 3 which contain the larger proportion of their metallic contents in combination with sulphides. The following are the usual methods:—

(*a*) If the sulphides are massive.

1. Hand-picking and after treatment as described below.

(*b*) If the sulphides (pyrites) are disseminated.

2. Wet stamping, combined with battery and plate-amalgamation, to extract the free gold, followed by fine concentration of the pyrites, and treatment of the hand-sorted ore and concentrates by smelting for lead, which yields bullion that has to be refined by different processes; or by smelting for copper in reverberatory furnaces, to produce an enriched copper matte.‡ The choice of these methods depends on whether lead or copper is the predominating metal. More frequently, however, the gold is extracted from the concentrates by the ordinary Plattner vat-chlorination treatment, whilst in a few special cases an iron matte is produced, and sold to smelters, or crushed and chlorinated.
3. Wet stamping, followed by amalgamation and fine concentration, and grinding the concentrates raw, in pans or Chilian mills.
4. Dry stamping, followed by roasting, with or without salt, and amalgamation in pans or barrels, a process which is only adapted, however, as a rule, to rich silver ores, carrying a certain proportion of sulphides, but not enough to pay for concentration.
5. The new cyanide-lixiviation-process, which is claimed to be applicable to the treatment of certain gold ores, much in the same way as the Russell process is to silver.
6. Ordinary lixiviation.

Dealing with ores belonging to class 4, which are amongst the most difficult to treat, because a process adapted to the extraction of gold may be very inefficient for the recovery of silver, and *vice versa;* when one metal is in small proportion as regards value, it is frequently sacrificed to the most profitable processes commercially for the other. Many of the base silver ores of the United States contain 5 to 15 dwts. of gold, and from 20 to 50 ounces of silver per ton. For such ores, dry stamping, roasting, and pan-amalgamation is mostly used, and under proper conditions will extract 90 per cent. or more of the silver, but only 40 to 60 per cent. of the gold. Lately, however, coarse crushing, instantaneous roasting in Stetefeldt furnaces, and double leaching by the new Russel process has come into prominence, and is said to be giving excellent results in certain instances, as regards economy and extraction of both metals.

* Transactions of the Federated Institution of Mining Engineers.

† *Trans. Am. Inst. Min.-E.*, vol. xx., page 150.

‡ The gold and silver in this matte are frequently extracted by a wet process from the copper-bottoms which contain the gold, after the silver has been extracted by the Ziervogel or Augustine processes.

The Russel process seems to be more particularly applicable to those ores which do not contain enough lead or copper for smelting, are poor both in gold and silver, and which contain large amounts of sulphur, arsenic, and antimony, since roasting with salt would convert the base metals as well as the silver into chlorides, and would give a very base bullion if it were amalgamated. There is, however, a remedy for this, which Mr. McDermott points out:* "When the silver is in combination with sulphides, antimonides, arsenides, and tellurides of the baser metals, the pan process becomes inefficient and expensive. By contact with iron surfaces, heat, and the addition of some chemicals—chiefly salt and sulphate of copper—a partial decomposition of the complex minerals is effected, and some of the silver amalgamated, but the wear of iron, loss of mercury, cost of power and chemicals, and the production of base bullion together, go far to neutralize the gain made in the recovery of the silver. In such a case a great benefit is derived by combining concentration with amalgamation. The light, flocculent chlorides and sulphides of silver can be amalgamated to a high percentage, while concentration is almost useless to deal with them in the form in which they exist in a free or decomposed ore.

On the other hand, concentration can be made very effective on the undecomposed complex minerals, for which amalgamation is ill-adapted.

There are two methods of combining the processes according to their order, concentrating either before or after the pan treatment. In regard to the relative advantages of the two, concentration before amalgamation is the natural method, because it relieves the pans of the baser minerals, which are a disadvantage in the amalgamation, and the subsequent concentration of which is made more difficult by the grinding or attrition of the minerals in the pans.

The only argument against the universal adoption of this order, rests on the disadvantages of sometimes having native metals, and some chlorides and sulphides entering the concentrations, instead of appearing at once as bullion which they otherwise would do, and also, that very perfect settling of the slimes from the concentration tails is necessary, to prevent loss of the flakey silver chlorides and sulphides. This process is in use at the Standard mill, California.

When the free metal is gold, the first-named disadvantage can be overcome by using copper plates before the concentrators, and this process was adopted by the Montana Company with great success, after first trying pans before the concentrators."

Comparing the combined process with dry crushing and roasting, the advantages of the former consist in a reduction of the cost of working fully one-half of that of dry crushing, a crushing capacity of double for the same number of stamps, a decreased cost of erection, and a higher saving of gold present. Against these advantages may be placed simply the increased percentage of silver saved by the dry process under certain circumstances.

When combined gold and silver ores carry over 10 per cent. of base metals it usually happens that the silver does not exist equally in the minerals present, but is concentrated in one of them as a rich, brittle ore. It follows from this, that concentration in some instances is very ineffective, because while 90 per cent. of the heavy base metals may be saved in the concentrates, the loss of the fine silver-bearing mineral in the slimes may be fully 50 per cent. of the assay value of the crude ore. In some cases the clean concentrated, heavy minerals do not assay more than the original ore from which they were separated.

This is a very strong argument against the injudicious application of fine concentration to all cases, for, as Mr. McDermott says, there are ores of both gold and silver in which the sulphides are so rich, that even a very small loss by weight involves a very large loss by assay of the precious metals.

Such minerals as tellurides of gold and silver, ruby and brittle silver ore, come under this head. In concentrating some of the tellurium ores of Colorado, some of the very finest slime material, overflowing from the concentration tanks of the Frue vanners, assayed as high as £5,000 per ton in gold and silver.

Where there is danger of loss, as described, it is advisable to introduce a double concentration, re-treating the tails on vanners.

For dealing with exceptional ores belonging to class 5: if their value lies mostly in tellurides of gold and silver, with little or no sulphides present, the most successful method yet found is by selection of the rich ore, and concentration (as above described), by double treatment of the low grade ores. Both rich ore and concentrates, are then so valuable, that smelting on the spot or shipment to smelters is advisable.

Another class of exceptional ores are those in which the gold is not free, so far as tests indicate, and yet there are no sulphides present.

These ores are generally oxidized in character, changed from their original form, and contain chloride of silver in addition to the gold. As some of these ores, when leached with hyposulphite of soda, yield a large portion of the gold as well as the silver, it would seem to indicate that the gold exists as a chloride, combined with the silver, either as a double insoluble chloride, or mechanically protected by the latter from being leached out by the natural drainage water of the mine. Such ores are uncommon, but have been worked to some extent by a raw leaching and concentration for the fine carbonate of lead, and its combined silver which is also present.

* Gold Amalgamation, by Walter McDermott and P. W. Duffield, page 88.

There may be other explanations, however, to account for the peculiar character of the ores just alluded to. On page 6 of Gold Amalgamation and Treatment, the losses of gold in milling are referred to five principal causes:—

1. Loss of free gold, quicksilver, or amalgam, due to carelessness or inexperienced amalgamation.
2. Free gold and gold-bearing sulphides, attached to or embedded in particles of rock.
3. Gold contained in base metal sulphides, broadly termed sulphides.
4. Gold lost in fine slimes, and sometimes in solution.
5. A condition of gold in which it is not susceptible of copper-plate amalgamation.

It is with the last of these that we now have to deal.

Quite recently* Mr. Richard Pearce, of Argo, Colorado, has given some most interesting facts with regard to the association of gold with other metals in Colorado, which bear on amalgamation and concentration. His investigations go to prove that gold and silver exist in some of these ores found below the water line, alloyed with bismuth, tellurium, and copper, and perhaps arsenic, where the presence of such combinations has hitherto been unsuspected, and a coarse-grained almost pure pyrites containing silver and a small value of gold, from the Louisville mine of Leadville, has been proved to contain metallic tellurium. When thus combined the gold would appear to be more or less refractory to the ordinary milling treatment, and this may account for some of the troubles set down to so-called rustiness.

A natural crystalline compound of gold and bismuth, has lately been discovered in Australia, it is said, and native alloys of these metals are known under the names of maldonite and bismuthaurite. Hessite, a natural combination of tellurium and silver (Ag_2Te) has been found in some of the Red Cliff veins, and a telluride of bismuth, probably tetradymite was found by Mr. Pearce in ore discovered at Ouray. He contends that, in certain cases, bismuth performs a by-no-means small part, in influencing the general deposition of gold, and also in causing the refractory behaviour of this metal under metallurgical treatment.

Mr. Pearce adds: "The occurrence of gold in this district seems to be intimately associated with that of eruptive porphyries, and the impregnation of veins with gold-bearing minerals is apparently always accompanied with silica. Evidence of intense thermal action† is one of the chief characteristics of gold deposits. Examples of these processes may be found in Gilpin, and also in Boulder County. In the latter district, known as the 'telluride belt,' there are indisputable evidence of vein impregnation by the circulation of siliceous waters through the joints of the porphyry; in this case tellurium is the chief mineralizing agent of the gold. Perhaps the most striking example of the deposition of gold, through the agency of thermal waters, may be seen in the celebrated Bassick mine, which has so often been described. This deposit exhibits all the characteristics usually accompanying geyser action The disintegration of the porphyry, with a partial replacement of the felspar by silica, is here clearly shown. The gold was combined almost in its entirety with tellurium, and rich tellurides of gold and silver were found sprinkled through the mass of material. In some remarkable specimens these tellurides formed a distinct coating on the surface of smooth boulders which had become rounded by attrition from the action of steam."

Dr. T. Egleston, in an elaborate paper on the causes of rustiness and some of the losses in working gold ores,‡ points out that the term rusty is used by miners to indicate a condition in which the metal is supposed to be coated superficially or alloyed with some substance, which prevents contact with mercury, and consequently precludes the possibility of amalgamation.

Gold in this state, it appears, is frequently covered with a brownish coating, which has a much redder colour than ordinary gold, and is irregularly distributed over its surface, where the least abrasion has occurred the metal underneath show the true gold colour. Fine particles of gold are sometimes visible with the microscope in the detached coating, and it often cracks off from pieces of gold, leaving them bright. Very often this film is composed entirely of silica, deposited on and beside the gold. It is sometimes opaque, and again quite transparent, so that the gold can be seen, with the microscope, disseminated through it, just as cinnabar-crystals are seen in the red chalcedony of the district around Knoxville, California. There may be, for example, many artificial causes which produce this rustiness of gold, the covering of the surface with particles of some foreign substance, or its alloyage with other metals, as already explained.

As Mr. McDermott remarks, concentration and pan amalgamation would probably be effective on the former class of ores, though for reasons that will presently appear the writer would like to add, or concentration preceded by crushing in centrifugal roller-mills, if other circumstances admit it. Dr. T. Egleston's view is, that the action of rubbing, which occurs in any machine like the arrastra, is much more likely than the stamp-mill to pulverize the fine pyrites, break up any coating that may be

* The Association of Gold Ores with other Metals in the West.—*Trans. Amer. Inst. Min. E.*, vol. xviii., page 447.

† The idea Mr. Pearce intends to convey (which is the writer's view of the matter) is that the filling of veins with mineral, is rather due in most cases to the leaching of the adjacent rock-masses, followed by a gradual replacement of the original constituents of the lode with ore, along certain horizons or belts, than to the action of thermal waters, building up masses of mineral in an open fissure, though both solfatara action, as Mr. Pearce remarks, at the Bassick mine, and sublimation in exceptional instances, may have tended to such a result.

‡ *Trans. Amer. Inst. Min. E.*, vol ix., page 646.

around the particles of gold, rub off the superficial deposit, and thus bring the gold into contact with the mercury and make it amalgamate. He states, as a remarkable fact, that in the early days, Mexicans with the arrastra, got 50 to 60 dollars a day, where stamp-mills, working the same rock, only obtained 15 to 20 dollars, and instances can be cited where, with the best modern machinery, only 20 to 30 dollars can be got out of rock which yields 700 to 800 dollars by fire assay.

Of course this might be due partly to the first cause of loss cited, viz, carelessness or inexperience on the part of the workmen running the mills, but this is on the whole unlikely. Amongst other causes in the treatment and composition of the ores which render gold unamalgamable in the mill, and which have to be considered and guarded against, Dr. Egleston mentions:

1. Gold which has been hammered, so as to increase its density and close its pores, amalgamates very slowly, a condition, however, which can scarcely be taken into account in the working of a stamp-battery, unless the gold is very coarse.

2. The presence of sulphuretted hydrogen in the water, likely to be induced by the presence of soluble sulphides.

3. Gold which has been exposed to the vapour of sulphur, which no doubt accounts for the behaviour of certain ores when submitted to amalgamation after roasting, and the same is doubtless true of arsenic in some instances, judging from Mr. Pearce's conclusions.

4. Certain alloys of gold, like the phosphide, though others like the arsenide and antimonide (produced artificially) are apparently more tractable. To these alloys must now be added the bismuthide, telluride, and cupride.

5. Greasy substances, like powdered natural hydrated silicates of magnesia and alumina, if present in the ore, froth and coat the gold with a slime, preventing the action of the mercury and lubricants, such as oil, getting into the battery box, are fatal to gold amalgamation.

The late Mr. E. N. Riotte once mentioned in the writer's presence a case within his experience, which occurred at a gold mine in one of the Southern States, where they had to abandon the use of dynamite on this account, as owing to the inexperience of the negroes in its use, portions of unexploded cartridges were left in the stone, and affected the battery yield. The result, if the nitro-glycerine had leached out and collected in a corner of the box, would doubtless have been a revelation to them.

6. Unusually soft water, absorbing air or carbonic acid gas, and so tending to form ferric sulphate (when pyrites is present), which is a most active agent in staining the plates.

Glancing back at the processes that have been referred to, it will be seen, that except in dealing with free-milling silver ores and a few special cases, there is considerable latitude given in the choice of a process, not to mention its details.

Its proper selection will depend on considerations of relative cost, as compared with saving or loss of metal, or other valuable products, that the ore contains; and nothing influences both of these in the same way, or either of them more, than the degree to which the crushing of the stone is carried, which is the author's next proposition.

The finer the crushing, and the more the ore is handled or re-handled, by repeating the operation, the greater of course will be the expense; while the more it is handled and the finer it is crushed beyond a point that is absolutely necessary, the greater also will be the loss. To reduce this latter to a minimum, a certain cost must naturally be incurred, though if it go a little too far, the cost is increased and the loss as well.

This happens under various circumstances, viz:—

A. In coarse concentration of the baser metals and of gold and silver ores, or a combination of both (applicable to the latter classes of ore, when the sulphides exceed say 10 to 20 per cent. by weight) to obtain the mineral with a minimum loss from comminution, the ore must be broken up, only just enough to unlock all the mineral it may contain, down to a certain size, and (theoretically) the mineral and barren rock with it should be separated at once. This will leave, however, a certain amount of yet more finely divided mineral in the residues, which require to be re-crushed and re-treated at so much additional cost, to get out the metal that remains in them, less of course a certain percentage of loss involved in this re-treatment.

When coarse combined with fine-concentration is necessary, it may then be considered how far it will pay, to carry theory into practice, and when labour is cheap, the life of the mine assured for a long period, and the ore of considerable value, the German practice may be adopted, of classifying carefully, reducing the ore gradually, and concentrating close; but when labour is dear, the life of the mine uncertain, and the chief object is to secure the largest possible profit in the shortest possible time at a minimum capital outlay, irrespective of a certain unavoidable loss in unrecovered mineral, the Anglo-American method must be adopted of sacrificing saving of mineral, to saving of cost and time, and crush the ore in quantity, to a much greater average degree of fineness, without such careful regard to sizing it.

The latter practice is the one followed in most American and colonial mills, employing fine concentration for gold and silver ores (when the sulphides in the ore do not run over, say, 10 per cent.) To compare these divergent systems roughly as to cost, two different cases one of a European zinc-and-silver lead mine, the other an American lead mine may be taken.

The works in Europe are those of the New Pierrefitte Co., which the writer was commissioned to inspect last summer, and of which he is permitted to give the following particulars:—

They are situated in the Pyrenees in France, and treat on ore containing galena, blende, magnetic iron, and a small amount of copper pyrites.

On an output of 21,449 tons of crude ore last year (averaging 9·33 per cent. of silver lead, and 11 per cent. of zinc) the cost of dressing, covering wages, supplies (including coal for three months of the year, water-power being used for the remainder), renewals of machinery, etc., may be taken at about 3s. 10d. per crude ton, as given below:—

Continental Works.

	Per Crude Ton. Francs.
Labour	2·35
Supplies and repairs	2·43
Total	4·78 = 3s. 10d.

American Works.

	Per Ton. Cents.
Labour	13·4
Supplies	3·5
Repairs	10·0
Coal	9·5
Total	36·4 = 1s. 6¼d

The American case is that of the new dressing works of the St. Joseph Lead Co., at Bonne Terre, Missouri.* The ore is non-argentiferous galena, associated with some iron pyrites, carrying traces of nickel and cobalt. On an output of 224,203 tons of crude ore in 1886-1887, averaging 5·65 per cent. of galena, the cost of dressing for the fiscal year, ending May 1st, covering labour, supplies, repairs, and coal, was (1s. 6¼d.) 36·4 cents, divided as above shown.

It would take too long to explain the differences of treatment in the two mills, suffice it to say, that the system outlined in both, is to crush with rock-breakers and rolls (preceded at Pierrefitte by spalling and cobbing), and then to jig and wash the ore on tables and buddles. The difference mainly is, that in the one case they give attention to sizing, and in the other they do not, though each mill in detail possesses certain peculiarities of its own. Neither can the relative number of workmen, cost of wages, supplies, etc., in detail be compared, as these data in the cost sheet are wanting, in the otherwise excellent paper quoted, from which the particulars of the Missouri mill are taken. In the French works, wages range from 1 fr. (10d.) to 2 fr. (1s. 8d.) for boys, and 2·75 fr. (2s. 2½d.) to 3 fr. (2s. 6d.) per day for the larger number of adult mill hands, and it is noteworthy that in both mills repairs and supplies (excluding coal from the American case) bear nearly the same ratio to one another.

It would appear at first sight that all the advantages lay with the American mill, and no doubt it does in America where labour is dear with the base ores that have to be dealt with in quantity where the works are situated. The case, however, would be entirely different if the American mill were transplanted to the Pyrenees, and set to work the silver ores of that locality, as the loss in the tailings at Bonne Terre is about 2·13 per cent., or 27·4 per cent. of the total amount of lead in the ore. These large losses are due to included mineral in the coarse-sands, and to very finely divided mineral in the very fine slimes, as a large part of the ore requires very fine crushing, owing to the exceedingly minute state of division of a large part of the mineral.

In the Pierrefitte works such losses with argentiferous galena could not be afforded, and though the writer is not in a position to state what they are exactly, they are far less than in Missouri. Moreover, the cost in the Pyrenees, with a larger output from the mine, could be materially reduced, as the works are not run up to their full capacity, and if their general design could be remodelled on the lines of more modern Continental mill-construction, the expense of treatment (if carried out on a similar scale as regards quantity) might be made to compare more favourably with the price in America without sacrificing mineral, in view of the lower price of labour.

To again quote Prof. Munroe, the losses in the Lake Superior copper mills range, it is said, from 28·5 to 31 per cent., treating mineral much more easily saved than the Bonne Terre galena, whilst the cost of dressing copper at the Atlantic mill in 1885, using steam stamps, is stated to have reached 30·36 cents (1s. 3⅛d.), divided between labour, 5¾d.; fuel, 7¼d.; supplies, 2½d. These costs were reduced, however, at the Atlantic mine in 1887 to 27·5 cents or 1s. 1¾d. per ton of copper ore treated. Incidentaly, Prof. Munroe states it is cheaper to crush ore* with rolls, arranged as they are in the Bonne Terre works, than the Lake Superior amygdaloid with steam stamps, but this is partly due to the friability of the Missouri ore; what is far more remarkable, however, is that the rolls produce (according to the Professor's statement) quite as large a proportion of slimes as the steam stamps.

Further, it should be noticed that the above instances of the cost of concentration in America are to be looked upon as a good deal below the average (at any rate of smaller mills), and as a general rule, coarse concentration, where rolls are employed for crushing, does not cost far short of 75 cents or 3s. 1½d, per ton, where labour rates are dear.*

The average cost of dressing different classes of ore in France is given by Dr. Foster and Mr. Galloway † (from a statement of Mr. Huet) as:—

	Per Ton. s.	d.
Iron ore	0	2
Coarse-grained galena	5	10
Fine-grained galena	7	10
Manganese ore	7	10
Copper pyrites, or grey copper ore with iron pyrites	9	9½
Coarse galena and blende	9	10
Fine galena and blende	11	10
Copper pyrites, or grey copper ore with galena	13	10
Copper ore, galena and blende	20	4

Though these figures may have been typical and true of French practice at the time they were compiled, the dressing-costs at Pierrefitte would indicate that they are much above the average at the present time; and, as the translators remark, there is always great uncertainty in estimating such working costs in a general way, for there is always uncertainty with reference to the labour required for shifting the stuff about, and principally with reference to the loss in dressing, to which might be added the attention required by different classes of machines when differently grouped.

If the American losses in dressing be compared with those in Germany it will be seen that the advantage rests with the Continental system.

Oberbergrath O. Bilharz, in a paper entitled "Die Neue Central Aufbereitungs-Werkstatte der Grube Himmelfahrt, bei Freiberg i.S.," puts the losses in the tailings of these works, at only 0·01 per cent. silver, *nil* per cent. lead, 10 per cent. sulphur, and 9 per cent. zinc. While the settlings in the final catch-pits ‡ carry only 0·01 per cent. silver, 2 per cent. lead, 8 per cent. sulphur, and 6 per cent. zinc.

Quoting the pamphlet referred to, the transcript of an article from *Industries* (in the *New York Mining Journal* of February 20th, 1892) and the writer's personal knowledge, he would like to refer to the Freiberg works more particularly, because he thinks they are illustrative of American principles, so to speak, engrafted upon former German practice, presenting a model of economy in costs, as well as economy in saving of mineral, to an extent which has never been achieved before, an advance which is undoubtedly in the right direction.

The ores which are obtained from the various shafts of the Himmelfahrt mine consist of argentiferous galena and zinc blende, with iron, copper, and arsenical pyrites, while the gangue is partly quartzose, partly sparry, mixed with the country (gneiss).

On account of the variety of the ores of the Freiberg district, the machinery of the dressing-floors is duplicated, so that ore from other mines can be dressed apart in the two sections, into which the mill is divided.

The annual production of the Himmelfahrt mines alone is 45,000 crude tons, of which four-fifths is concentrating ore, coming from what is known as the pyritic-lead formation (kiesige Blei-Formation) the remainder being rich silver ore and high-grade hand-picked galena ore, found mostly in cross-courses, carrying a gangue of brown spar and heavy spar.

These latter ores, representing one-fifth of the total production, are separated dry (hand sorted and dry stamped) and sent direct to the smelting works.

The dressing floors§ are designed to handle 150 tons of pyritic ore per shift of ten hours, each separate section dealing with 75 tons, with an average total consumption of 35 cubic feet of water per minute, the machinery being driven by steam power.

The ore averages 0·15 to 0·20 per cent. silver; and iron pyrites and galena are the predominating minerals. The zinc blende is black, and contains 33 per cent. of iron. The building is arranged in storeys, one above the other, and contains rock-breakers, screens, hand-picking tables, several sets of rolls, wet gravitation stamps, a variety of revolving screens and jigs, hydraulic classifiers, Stieen vanning frames, and other machinery (fully described in the papers referred to) which present many novel features of detail.

The horizontal compound-condensing engine which runs the whole crushing, dressing and electric lighting plant, indicates 105 horse power, and the works employ 44 workmen, with 3 overseers, 1 engine driver, 1 stoker, and 5 fitters, in all 54 men.

The cost of dressing one ton of ore amounts to 10d.

There are only five points which could be charged against the plant taken as a whole:—

1. That the design involves a considerable capital outlay (an objection, which it will be shown later on, is entirely swept away, when it conduces to and results in economy of treatment, provided that the mine warrants it, and that the working capital of a company can stand the necessary call without stinting the development of the mine.)||

2. That it may be doubted whether efficient roller-mills of the Schranz type, might not advantageously be substituted for the stamps.

* *Trans. Am. Inst. Min. E.*, vol. xvii., page 659, H. S. Monroe.

* Limestone.

* In exceptional cases the price may run up to 12s. 6d.

† *Lectures on Mining*, by J. Callon, vol. iii., page 134. Translated by C. Le Neve Foster, D.Sc., and W. Galloway.

‡ Only a fractional portion of the crude ore, which is re-treated.

§ The machinery was built and erected by Mr. C. Luhrig, of the firm of Messrs. Luhrig, of Dresden, in accordance with the plans of Mr. O. Billharz, who designed the installation.

|| As these works are a Government concern, this last consideration may in the present case be dismissed.

3. That, large as may be the reduction in labour as ompared with many other Continental plants of the same capacity, it might be still further lessened, given a better site than the one at Freiberg, which possesses but a moderate fall.†

4. That owing to the nature of the machinery, several skilled machinists, as well as facilities for making repairs on the spot, are very essential for running it properly.

5. That if anything goes wrong with any of its individual parts, the whole plant appears to be brought to a standstill. The writer was reminded of this by the practical illustration of a belt slipping off a pulley whilst he was going through the works two years ago. It is a matter, however, which is capable of remedy.

On the whole the advantages far outweigh any objections that can be urged, and the structural details of the plant, and erection of the machinery exhibit first-class skilled workmanship.

The stock required to be kept on hand in concentration works consists of duplicate parts of the machines, in more or less number, (depending on the distance from a source of supply and the average life of the different pieces in use).

The proposition stated on page 255 holds good.

B. In the fine concentration of sulphides (which generally accompany the precious metals) on belt or other automatic concentrators, which are so frequently used‡ as an adjunct to the stamp battery.

The size to which the stone is reduced under such circumstances influences very largely the chance of loss of mineral and gold, whether included in the coarser part of the tailings, or liberated as fine slime.

The cost of the actual mechanical fine concentration is not a matter of extremely serious consideration in itself, since assuming 18 tons of concentrates saved *per diem* in this way, crushing an ore containing 2½ per cent. of pyrites, the cost of treatment would not exceed 2d. or 3d. per ton, and dealing with much smaller quantities, 6d.; and further it will not vary much whether the ore is stamped coarse or fine, unless it involves a double concentration (that has been alluded to) dealing with rich ores liable to slime. But in order to concentrate in this way the ore must be stamped wet, and what applies to crushing fine with rolls, is also true of stamps. The finer the crushing the more it must cost in time, representing extra labour and a wear and tear, and also fuel, etc.

C. In stamping previous to grinding in pans, if carried too far, there will again be loss in the battery tails, whilst if not carried far enough, it will give the pans unnecessary work to perform, which would be much more cheaply done in the battery.

D. When the concentrates are treated (obtained by coarse or fine concentration or both combined) by such processes as smelting, chlorination, and lixiviation, it will be found that if it involves a preliminary roasting (as these processes generally do), if the ore is crushed very fine, and it carries much lead for instance, it entails a more careful regulation of the temperature, and unless a suitable type of furnace is used, with extensive dust chambers attached, great losses both mechanically and by volatilization may be incurred. On the other hand, if the ore is not crushed fine enough, and it is subjected to a chloridizing roasting with salt, the chlorination will not be as high as it should be, and the subsequent treatment will be proportionately affected by it.

E. If the ore is to be lixiviated or chlorinated, and the stone is crushed too fine, and at the same time of too uniform a grade, great loss of time and imperfect filtration and leaching will result, more especially if it is at all of a clayey nature.

The choice of a process, whether for treating crude ore or concentrates, must be governed by the relative commercial profits it promises, as compared with other methods of treatment. But before attempting to touch this question, it will be advisable to state certain general facts (under separate headings), giving an outline of several of the processes, which are later on compared, under the head of rival methods of ore treatment, in order to sim lify the subiect.

Roasting and Chlorination.

This is, ordinarily the best process to employ, for the treatment of the high grade pyritic concentrates of stamp mills, and hand picked sulphide ores, provided a sufficient quantity can be commanded to run the works full time or nearly so; intermittent work being bad for plant as well as for men. The ore should be kept moist after concentration, till it goes to the drying floors, as otherwise lumps will form which will not roast properly unless re-crushed.

The ore to be roasted is generally worked in reverberatory furnaces to expel the sulphur, arsenic, and other volatile compounds till it is dead sweet or as nearly so as possible. Then a small quantity of common salt is added, and the silver is chloridized, the sulphur is all driven off, and the ferrous and cuprous sulphates are oxidized.

The ore having been damped to about 6 per cent. is gassed with chlorine, a trichloride of gold being formed, which is leached out and precipitated with a solution of sulphate of iron. This gold is collected on filters, thoroughly washed, dried, and melted, and should average from 998 to 999½ fine.

When silver is present in sufficient quantity to justify the extra treatment, it can be recovered by re-leaching the residues with hyposulphite of soda or lime to dissolve

† Owing no doubt to its being the only site available on account of other reasons.

‡ Before adding concentrators of this kind to a mill, it is of course necessary to ascertain that the clean concentrates will assay enough to leave a profit on further local treatment, or shipment, to extract the gold, silver, or other metals they may contain.

the chloride of silver, which is precipitated from the lixivium by the addition of a solution of polysulphide of sodium or calcium, and the sulphide of silver resulting (collected on the filters) is washed, dried and reduced to the metallic state.

There is, however, one point to be guarded against in adopting this latter mode of treatment in dealing with ores, in which the percentage of gold is high, and about equal to the silver.

Kustel* remarks: "If such an ore should be subjected to chloridizing roasting, then impregnated with chlorine gas, leached with water for the purpose of extracting the gold, and finally leached with hyposulphite of lime for precipitating the silver, it would in this case, although a high percentage of silver might be extracted, result in a yield of gold that would hardly amount to 50 per cent., more or less. The reason is not easily explained. The gold may be influenced somehow by the base metal chlorides during the roasting, which prevents the gold being attacked by the chlorine gas."

On the other hand, if the base metal chlorides and the chlorides of silver are extracted previous to the impregnation with chlorine, both metals, silver and gold, can be got out very close by a process invented and patented by O. Hofmann, which Kustel fully describes in detail.

The gold and silver bearing sulphides of the Colorado No. 2, G. and S. M. Co., at Monitor, Alpine County, California (as an instance) were successfully treated by this method.

Should the sulphides contain any lead, it is advisable to conduct the liquor from the leaching vats to settling or storage-tanks, and about 40 lbs. of sulphuric acid (66 degs. B) is added. By this addition the lead is precipitated as sulphate, and the liquor, being freed from lead, can yield no plumbic sulphate with the gold, as it would otherwise do, when precipitated with sulphate of iron; hence a cleaner bullion.

In some chlorination works,† as the sulphate of lead obtained from the base tanks, always contains some gold, it is collected and sold, and a considerable sum is then realized for both lead and gold. The wooden tanks are protected from the action of the acids, by a coating of paraffin paint, and the covers of the chlorination vats are luted on with a mixture of tailings, bran and water.

There are certain pyritic ores, however, to which chlorination is unsuited. These include amongst others:

1. Ores of low grade, which run below, say £3 to £4 value per ton.

2. Those in which the gold is very coarse.

3. Those in which there is any mineral present, or other metal except silver and gold, in the gangue, liable to be attacked and rendered soluble by the chlorine, whilst gold must be either in a metallic state, or in a combination which can be destroyed by roasting without loss.

The impurities most to be avoided are sulphur, antimony and arsenic, since soluble salts of the base metals may precipitate the gold in the leaching vat; hence the necessity of what is termed a dead sweet roast before mentioned. Lead, lime and magnesia are also deleterious, as they are attacked by the chlorine, and waste a great deal of it, besides introducing difficulties in the after precipitation.

Mr. Nelson E. Ferry, M.E., in the New York *Engineering and Mining Journal* of November 28th, 1885, recommended the addition of molasses to the leach when lime was present. Mr. Ferry says: Dissolve one gallon of molasses in 30 or 40 gallons of water and keep for use. The quantity to use in each case must be determined by a laboratory test. If calcium sulphate comes down, either the molasses is in insufficient quantity, or it has not been thoroughly mixed. Examine by transmitted light. Avoid large excess of ferrous sulphate. If the gold comes down at first in a flocculent state, that does not matter, it soon assumes the usual form. The best results are got when the liquid is made slightly acid.

Mr. A. H. Aaron‡ recommends the use of precipitated copper sulphide as a precipitant,§ stirring it into the gold solution, or better, allowing the gold solution to flow through a series of small filters containing the sulphides. He states as a reason, that unless there is copper present to precipitate it, there is often a considerable loss from gold in suspension, due to imperfect settling.

The presence of galena, necessitates a good roasting with a strong finishing heat, as far as its fusibility will allow. This involves the use of a long hearth to raise the temperature gradually, as the charge progresses from one end of the furnace to the other. The roasted ore must be examined to see that no galena is left undecomposed

Any soluble iron chloride or other soluble metallic salt formed, will react on the iron oxide and precipitate the

* Roasting of Gold and Silver Ores, by G. Kustel, second edition, page 123.

† Eighth Report of the California State Mineralogist, page 47.

‡ Notes on the Hydro-metallurgy of Gold.

§ Mr. Claude Vautin, whilst admitting that precipitated copper sulphide (CuS) is a good precipitant in the laboratory, points out that in consequence of its physical condition, and the facility with which it is oxidized to $CuSO_4$, its application in practice is not to be recommended. He recommends fused sub-sulphide of copper (Cu_2S) as a perfect and rapid means of recovering the gold. To facilitate the filtration the Cu_2S is crushed to pass a 60 mesh sieve, and the portion which remains on a 100 mesh sieve only is used; this gives the desiderata of a dry, hard, and granular filter-bed, three points of importance. Whilst charcoal is not free from objections, on account of the large quantity necessary to ensure a complete decomposition of the solution, and the somewhat tedious and troublesome operation of "burning-off" the excess of carbon before smelting the residues, Mr. Vautin claims for this method the advantage that it is not necessarry to expel by heat or otherwise any excess of free chlorine from the solution before passing it through the reagent; nor does the presence of any free hydrochloric acid in any way interfere with the reaction. Any copper, calcium, zinc, etc., also passes through, presenting advantages over the use of hydrogen sulphide or ferrous sulphate.

gold, when dissolved, leaving it in the tails of the ore tanks after lixiviation. The addition of a little salt towards the close of the roasting, after the ore has been carefully oxidised, tends to counteract the effect of the lime and magnesia so often present in gold and silver bearing rocks.

Concentrates frequently contain iron as well as copper pyrites, galena, and arsenical pyrites, combinations which do not prevent the application of the process, unless the base metals, more particularly lead (but always excepting iron), are present in large proportions. Losses are likely to occur through the gold being volatilized or affected in roasting, which is more particularly to be guarded against if copper is present, and the ore be roasted with common salt. Much has been written on this subject, and in fact, enormous losses may occur in the chloridizing roasting of gold ores through volatilization of the gold.*

Mr. Kustel, page 57, records the loss of 20 per cent. of the gold contents in the oxidizing-roasting of certain tellurides of gold and silver, and states it is not a mechanical loss, but is due to volatilization. Though with most ores no loss of gold is suffered in this way during oxidizing-roasting, either with iron or arsenical pyrites, loss may occur if the operation be carried on so rapidly that fine particles are carried off by the draught.

A loss of silver in oxidizing-roasting is unavoidable. Plattner† concludes that the percentage increases with the temperature of roasting, and with the looseness or porosity of the roasting charge, that is with the facility with which the air can come into contact with the silver, and the freedom of the silver from combination with other substances. The loss increases also with the time of roasting. He concludes that silver is volatilized as oxide, which decomposes at a lower temperature into silver and oxygen, but Dr. Percy throws doubt on this theory.

In roasting, it is easy to incur an enormous loss of gold by inattention to what may appear insignificant trifles, showing how necessary in such matters is a systematic weighing and sampling, as well as assaying of the ores and products, in order to know at once when such losses are taking place, so as to be able to check them in time. Haphazard and occasional sampling and assaying, are worse than useless; they lead to great losses of valuable capital, frequently to the total abandonment of good properties, and worse than all to a false sense of self-satisfaction, which discourages investigation and improvement by denying the necessity thereof.

If the gold in the ore is of low fineness or combined with silver, a large part of it may be lost in roasting from a different cause, as the sub-chloride will surround the particles of gold, and prevent any further action of the chlorine upon it, in which case the double process, previously alluded to, must be employed.

The quantity of common salt used in chloridizing-roasting, and the time when it can best be added, are of much importance to the final result; and they have to be determined by trial, with different ores. The chlorine must be purified from everything that would be likely to cause a reaction between it and the other constituents of the ore.

Other important factors in the general success of the process are:—

1. Close and clean concentration.

2. Amalgamation of any coarse gold, preceding or following the chlorination.

3. Lixiviation of the silver before or after gassing.

4. Absence of any organic matter in the charge, or wash-water.

5. That the ore is crushed properly. A series of experiments should be made to ascertain how coarse the ore should be to give the best results with reference to economy, large capacity, and best extraction. The pulp for the best leaching must be in a granular condition, and carry as small a percentage of dust and slimes as possible. Mr. John E. Rothwell, (New York *Mining Journal* of February 7th, 1891) points out that for this purpose rolls, properly managed, are best adapted for this purpose. The chief point is to make the reduction in the size of the particles passed through them gradual. The ore should come to the coarse rolls not larger than ¾ inch, and these rolls should crush to about ⅜ inch. The middle rolls are set about $\frac{3}{16}$ inch or less apart, and the fine rolls about as far apart as the size to which the ore must be crushed. If only two sets of rolls are used, the coarse are set a little closer, and the fine remain the same. The springs should be tight enough in tension, not to give with the hardest ore passing through them, but lax enough to allow a piece of steel or iron to pass through without throwing off the belts. The periphery speed of the rolls should be the same or a little faster than the falling speed of the ore, and the ore should be fed in an even sheet across the surface of the roll. This will keep the surfaces true and produce a granular pulp but carrying a small percentage of dust. A still more gradual reduction can be made by making the rolls of larger diameter and narrower, which will give them also proportionately a greater capacity. Rolls of 39·5 inches diameter and 12 to 15 inches face have been used by Mr. Rothwell with good results.

Dr. T. Egleston writing on the formation of gold nuggets and placer deposits says: "I have known of gold (Grass Valley, California) being thrown down on the filter of a Plattner vat by the organic matter contained in the very impure wash-water used for the solution of the gold, rendered soluble by the action of the chlorine. The filter was full of metallic gold, and there was no means of ascertaining how much had been lost. Several ounces of a brown deposit were taken from it, almost pure gold."

* Losses in Roasting Gold Ores and the Volatility of Gold—*Trans. Amer. Inst. Min. E.*, vol. xvii., page 3.

† *Metallurgische Rostprozesse*, Freib, 1856.

An excess of chlorine must be present in the generator, and the ore must be washed and filtered thoroughly, otherwise the tub tails will assay 4 to 5 dollars instead of 75 cents.*

Lixiviation.

The MacArthur-Forrest Process for Gold Ores.

This process claims† to extract the gold from pyritic ores, without the necessity of roasting; and in certain cases it may have a considerable field of usefulness. When, for instance, the gold is in an extremely fine state of division, and the ore contains silver as well as gold, the fairly high percentage extracted of each metal may render this method a very desirable one.

For plain gold ores, in which the gold is in fine particles, the barrel-chlorination process seems, however, to give a higher extraction, and with ores of moderate and high grade appears to work to better advantage.

It would appear, in fact, that the limitations of the cyanide process might be summed up as follows:—

1. That it is only entirely successful with free milling ores, as although it will deal with pyritic ore, it does so at a greatly enhanced cost.

2. That it is inapplicable to ores containing a considerable percentage of coarse gold.

3. That it cannot be economically applied to rich material, as a loss of 2 dwts. in 8 dwts. ore is a very different matter to a loss of say 2 ozs. in 8 ozs. ore.

4. That it is not applicable to ores containing certain metal and mineral combinations.

On the other hand, it appears to be a process admirably adapted for saving gold in the condition of float, *i.e.*, in an extremely minute state of sub-division, which cannot be caught by any process of concentration or amalgamation.

Briefly outlined, the MacArthur-Forrest process originally consisted in pulverizing the ore to 40 or 60 mesh size, and then mixing, and agitating it, with a solution of cyanide of potassium (the ordinary standard strength of which was intended to be 1¼ parts of cyanide to 100 parts of water by weight).‡

After a sufficient time has elapsed for the solution of the precious metals, the leach is transferred to large wooden filter tanks, the solutions are allowed to settle, and are drawn off (sometimes assisted by pressure or suction), and the gold and silver contained in these solutions as cyanides, are decomposed and precipitated in a metallic condition, by passing the filtrate through metallic zinc turnings. In the course of this treatment the zinc replaces the gold in solution as cyanide of zinc, which dissolves in the water, while the gold is deposited as a dark powder. This is separated by sieving from the undecomposed zinc, when it is found, by testing with chloride of tin, that the whole of the gold has been precipitated from the leach liquor.

The zinc residues are then removed and dissolved in nitric acid, the gold remaining undissolved as a dark brown powder, which is washed, dried, and melted, yielding almost pure gold.

If there is any silver present it is dissolved with the zinc, and can be recovered by adding a solution of common salt, which throws it down as chloride. It has then to be reduced to the metallic state by contact with sheet-iron or zinc, after which it is washed, dried and melted.

The chemistry of the process§ is simple, depending on the affinity of cyanogen for gold and silver, and the ease with which these metals form soluble double cyanides with the alkali metals. The relative affinities of the different metals, according to Mr. Wm. Jones, stand as follows: 1st, gold; 2nd, silver; 3rd, copper; 4th, zinc, lead, arsenic, antimony, etc.

The solvent action on the base-metals can be reduced to a minimum by reducing the strength of the solutions, the readily soluble gold and silver being dissolved out with only traces of copper, zinc, etc.

The best strengths of solutions to use in leaching out the gold from refractory stone depends entirely on the nature of each ore, and it is impossible to lay down any hard-and-fast line. The point must be determined by practical tests.

Filtration of the liquor is accelerated by using a vacuum, and there is no practical difficulty about this, unless there is a large percentage of clayey matter present. The amount of free cyanide in the liquors, after passing through the zinc, is then determined by means of a standard solution of nitrate of silver, and the liquor is thereafter made up to its original strength and used over again.

To extract the gold from refractory ores a number of points must, however, be observed. If the ore betrays a noted acidity, due to the presence of basic sulphates of iron, etc., (especially marked in the case of disintegrated and weathered sulphides), it should be neutralized with an equivalent quantity of caustic lime in the form of milk of lime. The exact amount of acidity can be determined by shaking up a weighed sample of the ore with water, and adding standard-normal or tenth normal caustic soda solution till the point of alkalinity is attained, as indicated by litmus or any other suitable tests. The amount of lime is then easily calculated. Some ores show as much as 4 per cent. of acidity in terms of soda, and such ores, on treatment with cyanide solutions without previous treatment with lime, fail to yield their gold contents, whereas when previously treated with lime, the greater part of the gold is easily extracted.

* Phillips, *Trans. Am. Inst. Min. E.*, vol. xvii., page 313.

† Memoranda on the Treatment of Refractory Gold Ores by the MacArthur-Forrest Process.—Wm. Hodge & Co., Glasgow.

‡ In actual practice, however, these ideas have been modified, and what is known as the percolation system has come into almost universal use, employing standard solutions of a certain strength, first leaching the ore for 6 to 12 hours with 6 to 8 per cent. solution, and for 8 to 10 hours more with a weaker liquor, containing 2 to 4 per cent. of cyanide.

§ The MacArthur-Forrest Process for the Treatment of Refractory Gold Ores.—*Eng. and Min. Jour.*, New York, 1889, vol. xlviii., page 544.

Nearly all sulphides show more or less acidity, but when it is under 0·10 per cent. it may for practical purposes be neglected.

The cyanide solution used should be as free from caustic alkali (NaHO or KHO) as possible, as it is apt to form a sulphide of sodium or potassium with the sulphur of the ores, and thus prevent the gold and silver going into solution. This difficulty, when it does occur, is got over by adding calcium chloride.

The cyanide solutions are best preserved from too great exposure to the air, as a part of the cyanide is apt to be converted by oxidation into the cyanate.

From a chemical point of view it appears that the economic success of the process, will mainly turn on the price, and consumption of chemicals, and on the time taken in treating large quantities, to extract a given percentage of gold from various combinations of ores in different localities in which the gold exists in a coarse or fine state of division, and in different alloyage, and in which the pyrites is more or less highly concentrated. The ores of the Witwatersrandt seem specially adapted for treatment by this process.

The Russel Process for Silver Ores.

Quoting Mr. C. A. Stetefeldt, on the lixiviation of silver ores, Mr. E. H. Russel, it is said, discovered that a solution of a double salt of cuprous hyposulphite and sodium hyposulphite (formed by mixing sodium hyposulphite with copper sulphate), exert a most energetic dissolving and decomposing action upon metallic silver, silver sulphide, silver minerals belonging to the group of antimonial and arsenical sulphides, and other silver combinations. Hence, if a charge of roasted ore is first lixiviated with ordinary sodium hyposulphite solution to dissolve the silver chloride, and subsequently with cuprous hyposulphite (this solvent is called the extra solution) an additional amount of silver is extracted, which would have been lost in the tailings, by working according to the old method alone. Or, if the roasted ore contain caustic lime and be treated with the extra solution, the deleterious influence of the caustic lime is thereby neutralized. In the same way the extra solution may be applied to extract silver from raw ores without previous chloridizing-roasting, or to lixiviate ores after they have been subjected to an oxidizing-roasting. Mr. Russel also discovered that lead can be completely separated from a sodium hyposulphite solution, as lead carbonate, by sodium carbonate, without precipitating copper or silver.

After decanting the solution from the lead carbonate, silver and copper are obtained from it in the usual way. This method of separating lead prohibits the use of calcium polysulphide as a precipitant for the sulphides, because calcium, entering the regenerated lixiviation solutions, would also be precipitated as a carbonate with the lead, by sodium carbonate; hence sodium sulphide must be employed. A full investigation has demonstrated that this is by no means detrimental, as sodium sulphide and sodium hyposulphite are more advantageously used in the lixiviation process than the corresponding calcium salts.

Finally, Mr. Russel found that if a hyposulphite solution has a caustic re-action, produced by caustic soda or lime, its solvent power for silver is materially deteriorated. This defect he corrects by neutralizing such a solution with sulphuric acid.

The Van Pattern Process (Ordinary Lixiviation.)

This process consists in: (1) Crushing the ore (generally with rolls). (2) Drying the ore. (3) Roasting with salt. (4) Leaching out the base metals with hot or cold water.* (5) Leaching out the silver with hyposulphite of soda. (6) Precipitating the silver. (7) Roasting the sulphide of silver and melting the bullion.

It is capable of saving about 85 per cent. of the silver in the chloridized ore, assuming it to be suited to this class of treatment.

(To be continued.)

Incline Truck Drop for Calcining Kilns.—A new incline truck drop for use in connection with calcining kilns is described by Mr. C. Wood, in a paper read before the Cleveland Institution of Engineers. This drop was designed for lowering the trucks from the top of the kilns at the Tees Ironworks, where the space was very limited, and for that reason a drop of the ordinary design was not admissable. After a description of the form of drop usually employed in the district, the details of the latter design are given. Four columns support girders, on which is mounted a shaft with four rope pulleys and a brake-sheave. The counter-balance weights work inside the two main columns. These stand on one side of the centre line of the kilns, from which the truck is run on to the lowering table, its weight being so placed as to keep the guide wheels in position. The table at the bottom of its travel is tilted automatically, and the stops withdrawn so as to discharge the trucks on the same side as that on which they were received.

* The base metal chlorides in the water may carry off 0·5 to 3 per cent. of silver, but this can be recovered by simple dilution, unless chlorides of lead and antimony be present (which are likewise precipitated), in which case either the ore must be leached from below, under slight pressure, or the silver must be precipitated in troughs outside the tubs.

On the Nickel Ores of Canada.

[Translated from the French of M. David Leval, Mining Engineer, Paris, France. Annalles des Mines, 9th Ser., Vol. 1, 1892.]

Location.—The first notice of the occurrence of nickel deposits in the Province of Ontario dates back to 1846,* but no one ever dreamed of extracting the metal or of utilizing its ores until the building of the Canadian Pacific Railway. There is a map published by the Canadian Pacific Railway Co. which points out the exact location of this district and the various railway lines in connection therewith. The most important place in this whole region along the belt of country lying between Lakes Huron and Nipissing, is Sudbury, a station on the C.P.R. and Algoma Branch R.R.

The country is covered over with dense forests partially devastated by fires, but which make the country no less easy of access and investigation to the mining inspector. Streams flow in abundance in the valley during a portion of the year only, for in winter everything is clad with a mantle of snow, for the climate is rigorous.

Mode of Occurrence.—Nickel is here found associated with the magnetic iron pyrites along with copper, in the shape of chalcopyrite. These very mines were first of all worked for copper.

The ore occurs in large lenticular accumulations, interstratified between bands of gneiss belonging to the primary system of North America.

This system consists of two subdivisions. The Laurentian, chiefly gneisses, and the Huronian, formed by green hornblendic rocks and talc schists. The gneisses of the Sudbury region are noteworthy on account of their enormous development to a breadth of more than 1,000 metres (metre equals 39⅜ inches), and by the phenomena of metamorphism which they indicate. There occur, notably granwackes and quartzites, various kinds of diorites, hornblende schists, mica schists, diabases, argillaceous grits, and the whole series associated with volcanic breccias.† The Huronian of Sudbury is above all represented by the red quartzose syenite.

The entire formation has suffered numerous crumplings and foldings, so that it presents a strong inclination or dip amounting to 70 degrees at times. The general axis of up-lift in these rocks is north-east and south-west, but the numerous faults and foldings which affect the formation cause modification of structure in different places.

An important note regarding the deposits in question is their intimate connection with the intrusive diorites which penetrate and cross the gneisses and granwackes. It is at the contact of the diorite masses or near them that the magnetic iron pyrites outcrops occur. These sometimes penetrate the diorites. This diorite furthermore assumes various grades and appearances according to the predominance of the quartz feldspar and hornblende which constitute its mass. Diorite forms the gangue of the ores, a fact which is favorable to their treatment by the fusion process, this rock being relatively but slightly quartzose is preferable to the purely quartzose gangues which generally accompany similar deposits.

Method of Extraction.—The extraction of the Sudbury ores is in the hands of a number of different companies with effective and perfected means at their disposal. Only those mines in the immediate vicinity of the railroad are worked at present, but there is a large number of similar deposits unexplored, unknown or insufficiently recognized owing to the roughness of the district. Nevertheless, from official report addressed to the Secretary of the Navy of the United States in October, 1890,‡ there was then a cubic mass of ore of over 650 millions of tons in the various mines, and the total output of ore up to that date, for a period of two years, was about 160,000 tons. These figures suffice to indicate the economic and industrial importance of Canada in so far as the production of nickel is concerned.

Composition and Average Yield of the Ores.—The average or mean composition of the ores scarcely goes beyond 3 or 4 per cent. of nickel and about the same quantity of copper. The ores of the "Canadian Copper Company" appear to be relatively less rich in nickel than those of the "Dominion Mineral Company." They all appear to become richer in useful metals as the shafts are sunk in the process of extracting the ores.

The following is a sample of the composition of an average ore, chosen as an ore of copper:—

Sulphur	26.717 p.c.	
Copper	12.610 "	
Iron	29.220 "	
Nickel	3.120 "	
Protoxyde of Iron	6.22	Gangue, 29.36 p. c.
Lime	4.84	
Magnesia	2.61	
Alumina	2.63	
Silica	13.06	

Then follow a series of notes giving the results of explorations and mining operations carried on by Mr. E. D. Peters, and prepared by him—"Transactions of the American Institute of Mining Engineers." The paper is called "The Sudbury Ore Deposits," and has already been noticed by the Canadian Mining Review at the time it appeared. The other work of reference quoted is a report by M. J. Garnier, published in the "Memoires de la Société des Ingenieurs civils, Mars, 1891," and en-

* Dr. T. Sterry Hunt, in his "Report to the Canadian Government."

† Dr. Bell. Bulletin Geol. Soc. America.

‡ Sudbury nickel deposits, reports by experts to the U. S. Government, 1890.

titled : "Mines de nickel, auvre et platine du district de Sudbury (Canada)."

This elaborate report then describes in detail the methods of extraction at the "Creighton," "Stobie" and other mines, and the valuable deposits of the "Copper Cliff" mine, the "Evans" and "Blezard," which contain from 3 to 5 per cent. of nickel and about the same quantity of copper.

The writer notes the cost of work and considers the wages of $1.50 to $2.50 per day as dear and the hands scarce, thereby necessitating the company to house and board their staff of miners in order to practice economy.

Cost of Extraction.—By the time the ore has reached the roasting heaps the average cost per ton is $2, along with a proportion of poor ore, brought out above ground of 50 p.c. grade.

Roasting.—Roasting is carried on exclusively in heaps. Upon the good behaviour of this operation depends the success of fusion. Therefore it follows that a great deal depends upon the construction of the heap, and much care is exercised therein. Roasting is given out by contract at 20 cents a ton for heaping and roasting, and 30 cents a ton for taking and brought to the smelter, making in all 50 cents a ton. The companies furnish the tools and wood necessary for the roasting process, which makes the total average cost per ton of about 60 cents. The wood used is pine, abundant throughout the region and costing about 50 cents a cord brought to the works.

The grounds for roasting cover a considerable area, and the fumes which emanate from the heaps destroy the vegetation all around. There is little or no arable soil there. The present accommodations enable the companies to roast 500,000 tons of ore, which take from 50 to 60 days for a heap of from 500 to 600 tons, the dimensions of the heap being about 100 ft. long and 20 ft. wide.

Fusion of the Roasted Ores.—The fusion of roasted ores is the most interesting operation and treatment of the Canadian ores. It is effected in large water jackets of steel sheeting of 3 millimetres in thickness, elliptical in form and all one piece from the crucible up to the supply door. The bottom of the oven is closed by means of a cast iron plate lined with refractory bricks; the scoriæ and matte are drawn or flow out together in a fore crucible, with cool sides, borne on a truck to facilitate its removal. A low dome of steel plate lined inside with bricks carries the fumes into the condensing chamber of the powders and thence to the chimney. On the opposite side is the lateral supply door to let in the fusion bed and coke.

The Constitution of Nickeliferous Pyrrhotite.

By Dr. S. H. Emmens, Youngwood, Pa.

It is the custom of mineralogists to speak of many mineral varieties as formed by one metal "replacing" another to a greater or less extent in certain chemical combinations. This is, I think I may say, the invariable account given in the text books respecting nickeliferous pyrrhotite, a mineral described as consisting of an iron sulphide in which "part of the iron is replaced by nickel." The object of the present paper is to enquire whether the account in question is a correct representation of the facts of the case, or whether the constitution of nickeliferous pyrrhotite differs from the description given in the text books.

The general formula of pyrrhotite is $Fe_n\,S_{n+1}$. This is sometimes written $n\,(Fe\,S).\,Fe_2S_3$ or $n\,(Fe\,S).\,Fe_2S_3$; though probably, for reasons analogous to those recently set forth (Journal of Analytical and Applied Chemistry, Vol. VI., No. 10, October, 1892), the more correct view is to regard the typical compound, Fe_3S_4 as being a homogeneous body, and not as being composed of a mixture of sulphides. This question, however, is comparatively unimportant in the present discussion; as, whatever may be the precise arrangement of the molecules, their number will not be changed, and pyrrhotite will still be defined as an iron sulphide composed of n molecules of Fe and $n+1$ molecules of S. And, on the "replacement" theory, nickeliferous pyrrhotite will be a sulphide composed of x molecules of Ni, $n-x$ molecules of Fe and $n+1$ molecules of S. Let us test this numerical theory by the actual results of analysis.

At p. 74 of the 6th edition of Dana's *Mineralogy* is a table of analyses of various specimens of pyrrhotite. From this I will select the following for discussion, namely:

	S.	Fe.	Ni.
No. 14. Brewster, N. Y. . .	37.98	61.84	0.25=100.07
" 15. Putnam Co., N.Y.	39.28	60.03	0.78=100.09
" 15a. " "	38.99	60.04	1.02=100.05
" 15b. " "	39.85	58.73	1.53=100.11
" 20. Frigido	39.65	58.18	2.17=100.
" 18. Hilsen	40.27	56.57	3.16=100.
" 17. Sudbury	38.91	56.39	4.66= 99.96
" 19. Gap Mine, Pa. . . .	38.59	55.82	5.59=100.

Now it is obvious that any replacement of iron by nickel must take place by whole molecules weighing respectively 58.6 for Ni and 55.9 for Fe. Hence for every Ni molecule in mineral No. 14 of the above list there must be $\frac{58.6}{.25} \times \frac{61.84}{55.9} = 259.3$ molecules of Fe; and, in like manner, there must also be $\frac{58.6}{.25} \times \frac{37.98}{32} = 278.2$ molecules of S; or, in view of the analytical total being a little in excess of 100, we may regard the mineral as consisting of $Ni\,Fe_{259}\,S_{278}$ instead of $Ni\,Fe_{259}\,S_{261}$, as called for by the pyrrhotite theory.

Similar calculations in the other cases give the following results:

No. 15. . . . $Ni\,Fe_{80.68}\,S_{92.22}$ showing an excess of $S_{9.54}$
" 15a. . . $Ni\,Fe_{61.71}\,S_{70.00}$ " " $S_{6.29}$
" 15b. . . $Ni\,Fe_{40.24}\,S_{47.69}$ " " $S_{5.45}$
" 20. . . . $Ni\,Fe_{28.11}\,S_{33.46}$ " " $S_{3.35}$
" 18. . . . $Ni\,Fe_{18.77}\,S_{23.34}$ " " $S_{2.57}$
" 17. . . . $Ni\,Fe_{12.685}\,S_{15.29}$ " " $S_{0.605}$
" 19. . . . $Ni\,Fe_{10.468}\,S_{12.642}$ " " $S_{0.174}$

In none of these minerals does the formula $(Fe\,Ni)_n\,S_{n+1}$ hold good; and we therefore have reasonable ground for declaring that the constitution of nickeliferous pyrrhotite is *not* represented by this time honored but somewhat superficial generalization.

It will be noticed that the excess of sulphur bears some relation to the percentage of nickel; the lower the nickel contents the greater being the surplus of sulphur, and *vice versa*. This necessarily follows from the great size of the compound molecule when the percentage of nickel is small. If, however, we investigate the proportion borne by the sulphur to the total metal, we shall find a tendency to constancy rather than to variation, as is shown in the following table:—

Per Centage of Nickel.	Proportion of S Molecules in Excess of $n+1$ to		
	Ni Molecules.	Fe Molecules.	Ni+Fe Molecules.
0.25	16.9	.0652	.0649
0.78	9.54	.1182	.1168
1.02	6.29	.1019	.1003
1.53	5.45	.1354	.1322
2.17	3.35	.1192	.1151
3.16	2.57	.1369	.1300
4.66	0.605	.0477	.04421
5.59	0.174	.0166	.01517

This suggests that the constitution of nickeliferous pyrrhotite is polymeric; an inference which is also supported by the fact that Nos. 17 and 19, containing the high nickel percentages of 4.66 and 5.59, show less than 1 complete molecule of sulphur in excess, and therefore require a multiplication of their several figures. Taken as a whole, however, the results of analysis are opposed to any assumption of homogeneity of structure.

Coming now to physical investigation, we are at once met by a feature that is conclusive against the hypotheses of "replacement" and homogeneity. I allude to the fact that nickeliferous pyrrhotite may be divided into two portions, one of which is magnetic while the other is non-magnetic. This fact has long been known to chemists. In 1879 Habermehl effected a separation of the magnetic from the non-magnetic portions of pyrrhotite for the purpose of obtaining a pure mineral for analysis. In 1890 T. J. McTighe applied magnetic separation in the treatment of the nickeliferous pyrrhotite of Canada; and in July of this year T. A. Edison applied for a U. S. patent in respect of virtually the same invention, and filed a specification containing the following statement:—

"I have discovered that where magnetic pyrites, called "pyrrhotite" is nickeliferous, as it usually is to a more or less extent, the nickel is not distributed generally throughout the whole body of the pyrhotite, but certain crystals are pure pyrrhotite or magnetic pyrites, while other crystals have some of the iron replaced by nickel and sometimes by cobalt, and that the crystals containing the nickel or cobalt are considerably less magnetic than the pure pyrrhotite."

Any statement made by Mr. Edison is deserving of respectful attention; but I believe that gentleman has frequently disclaimed anything beyond a rudimentary knowledge of chemistry and is therefore presumably open to correction in matters belonging to that department of science. Be this, however, as it may, I am safe in saying that pyrrhotite is rarely found in a crystalline form, and that crystals of nickeliferous pyrrhotite are as yet unrecorded as having been observed. Mr. Edison's mention of "crystals" is probably only a loose way of describing the minute fragments, particles or grains into which the massive pyrrhotite is divided by comminution.

Again, Mr. Edison speaks of the strongly magnetic particles as being "pure pyrrhotite," meaning thereby a non-nickeliferous iron sulphide of the general form $Fe_n\,S_{n+1}$. My own observations do not confirm the statement that nickeliferous pyrrhotite can be magnetically separated into nickeliferous and non-nickeliferous portions. A separation into two very distinct minerals or mineral mixtures is possible, and these contain very distinct percentages of nickel; but both are nickeliferous. The following results obtained by Mr. C. T. Mixer at the laboratory of the Emmens Metal Company will illustrate this.

Two samples of nickeliferous pyrrhotite were taken, one from the Gap mine, Lancaster Co., Pa., and the other from a mine near Sudbury, Ontario. These were very finely powdered and then each sample was carefully separated by means of a magnet into three grades, namely, "magnetic," "feebly magnetic" and "non-magnetic." The "magnetic" and "non-magnetic" grades were then analyzed and resulted as follows, after deduction of gangue:—

	Ni.	Fe.	S.
Gap *magnetic*. . . .	0.35%	59.97%	39.68%
" non-mag. . . .	15.59	43.00	41.41
Sudbury mag	1.30	58.27	40.43
" non-mag.	23.16	33.92	42.92

Treating these figures in the same way as those of the analyses recorded by Dana, we have:—

1. Molecular Constitution.

Sudbury mag . . . . $Ni\,Fe_{46.99}\,S_{56.95}$ showing an excess of $S_{7.96}$
" non-mag. $Ni\,Fe_{1.535}\,S_{3.394}$ " a deficiency of $S_{0.141}$
Gap mag . . . . $Ni\,Fe_{179.6}\,S_{207.6}$ " an excess of S_{26}
" non-mag . . . . $Ni\,Fe_{2.891}\,S_{4.864}$ " a deficiency of $S_{0.027}$

2. Proportion of Excess S to Metal.

Percentage of Nickel.	Proportion of S molecules in excess of $n+1$ to Ni molecules.	Fe molecules.	Ni+Fe molecules.
0.35	26.00	.1448	.1440
1.30	7.96	.1694	.1659
15.59	Slight deficiency of S.		
23.16	"	"	"

A comparison of the results here obtained with those from Dana shows conclusively that the magnetic minerals are of the pyrrhotite type, but that the non-magnetic concentrates are of a quite disimilar constitution; and as the latter are much higher in nickel than the former it is also clear that the nickel is *not* present as an element replacing iron in pyrrhotite. It is also apparent that the minerals Nos. 17 and 19 of Dana are mixtures of the magnetic and non-magnetic minerals found in the Gap and Sudbury samples examined by Mr. Mixer.

Much additional investigation is needed to determine the true constitution of pyrrhotite and its allied nickel compound. It may be that experiments as to the solvent action of molten ferrous sulphide upon iron disulphide and nickel sulphide will throw the needed light upon the subjct. Many geologists are of the opinion that the massive pyrrhotites of Canada and other places are the cooled remains of a molten mass: and every parcel of matte produced from a smelter is an object lesson respecting the varying mixtures that are possible under such conditions. Provisionally, therefore, we may regard the constitution of the minerals under discussion as represented by the following formulæ:—

Crystalline pyrrhotite . . $n\,(Fe_3\,S_4)$
Amorphous do . . $n\,(FeS).\,x\,(FeS_2)$
Nickeliferous do . . $n\,(FeS).\,x\,(FeS_2).\,y\,(NiS)$

In conclusion it may be well to say a word as to the practical problem of the magnetic concentration of nickeliferous pyrrhotite. The two samples above referred to as examined by Mr. Mixer gave the following results: 2 nickel pyrrhotite

1. Division of the total sample:

	Gap.	Sudbury.
Magnetic portion	58.66 per cent.	92.95 per cent.
Feebly magnetic portion	6.67 "	2.09 "
Non- " "	34.67 "	4.96 "

2. Division of the total nickel contents:

	Gap.	Sudbury.
Magnetic portion	16.25 per cent.	58.01 per cent.
Feebly magnetic portion	19.96 "	7.60 "
Non- " "	63.79 "	34.39 "

3. Total gangue in sample:

Gap . . . . 41.28 per cent.
Sudbury . . . . 10.7 "

4. Division of the total gangue:

	Gap.	Sudbury.
Magnetic portion	25.85 per cent.	75.51 per cent.
Feebly magnetic portion	7.12 "	9.07 "
Non- " "	67.03 "	15.42 "

5. Percentage of gangue in the portions:

	Gap.	Sudbury.
Magnetic portion	18.20 per cent.	8.70 per cent.
Feebly magnetic portion	44.00 "	46.60 "
Non- " "	79.80 "	33.20 "

The practical inferences from these figures are as follows:

1. Magnetic separation will give a rich nickel concentrate.
2. An ore with considerable gangue will yield more of its nickel as "concentrate" than will be the case with cleaner ore.
3. The concentrate from clean ore will be of a higher grade than that from ore carrying much gangue.
4. The nickeliferous portion of the mineral is attached to the gangue more firmly than is the non-nickeliferous portion.
5. The nickel is *possibly an essential constituent of the gangue instead of being a constituent of the pyrrhotite.*

This last inference is so opposed to the generally received teachings that I have instituted a fresh series of investigations with a view to determine its correctness or the reverse. The results shall in due course be communicated to the American Chemical Society; and, in the meantime, all I can say is that at present they seem to favor the supposition of the gangue being nickeliferous.

The Use of Safe Explosives in Mines. *

By E. Gilpin Jun., M. Can. Soc. C. E.

The question of the use of explosives in the provincial coal mines was forced on the attention of the Nova Scotia legislature by the explosion at Springhill. Here apparently no trouble had been spared by the Company to protect its workmen. The locality in which the explosion originated was worked with safety lamps, the shots were fired under the direction of skilled men specially appointed for the purpose, and then at long intervals, not for loosening the coal, but to remove a few inches of stone in part of the roof. Copious watering was resorted to for laying the dust wherever the workings were not naturally damp. In spite of these precautions it appeared upon a careful enquiry that a charge of gunpowder had partially done its work, had flamed out, and the heat acting upon an atmosphere containing dust and gas gave rise to a very serious explosion. This showed that the mining practice of firing charges of gunpowder in places where dust and gas could be present was dangerous in spite of the precautions regarding its use.

After deliberation the Legislature enacted that when gas was found in any mine, in quantity sufficient to show in a safety lamp in three consecutive days, no explosive could be used for two months.

Provision was however made, that the Governor-in-Council could, upon the recommendation of a commission, including the Inspector and persons skilled in the use and composition of explosives, that any explosive was safe, relax the act in respect to explosives in favor of such safe explosive.

In considering the practical application of the use of explosives in coal mines, the first point to be settled is what constitutes a "gassy" mine, that is a mine in which the use of gunpowder becomes unsafe. The theoretical definition is that any mine in which gas is known to be given off may present it in volume sufficient to be ignited either alone or in connection with dust by the explosion of gunpowder. As a matter of fact small percentages are known by special tests to be present almost continuously in mines, although they cannot be detected by the best safety lamps in use. In all parts of the world in well ventilated mines, gunpowder has been continuously used for years with impunity in the presence of these minute percentages of gas. In such mines provided that they are damp, and free from dust, there is little danger even from excessive charges, or blown out shots of powder, so long as the ventilation is adequate.

Such mines when carefully managed and under proper discipline gradually and by imperceptable degrees, pass, as they are worked at an increased depth, into what may be termed the second stage, that of an increased evolution of gas, and usually of a greater degree of dryness. When this stage is reached a deficiency of ventilation in any district, coupled with dryness of the workings, produces a state of affairs highly dangerous in the event of flaming or blown out shots. The third stage is that of deep workings, which add to the dangers of increased exudation of gas, and general dustiness, those of extended fracture of the strata suddenly introducing volumes of gas directly into the workings or pressing it out of the old goaves. Under these conditions prudent management introduces safety lamps and abolishes the use of gunpowder. The second stage is the most dangerous, as when the conditions of safety and danger are balanced, a trifling mishap paves the way for a disaster.

Mining practice has so long sanctioned the use of open lights and high explosives in mines that have reached the second stage, that the reaction now setting in, in favor of their restriction, promises to seriously affect the economic exploitation of some coal beds. The Prussian Commission went so far as to classify as "gassy," mines in which gas had been detected once in two years. It is therefore apparent that in almost every district there are mines varying in their degree of danger. Any hard and fast rule, for example, precluding the use of high explosives whenever gas is found, would not affect the mines of the third stage, but would greatly increase the cost of the coal from the comparatively non-gaseous mines. In the case of many mines giving off little gas, there are serious expenses, off-setting the cheapness with which the coal is mined, such as faults, steepness of dip, the presence of stone, weakness of the roof, etc. Such mines would find it difficult to produce coal, if explosives were abolished.

As it was apparent that a mine at any given time fairly classed as not "gassy" might in a few days on cutting a fault, giving off gas, or entering a disturbed section of coal, become decidedly "gassy" it was considered that the limitation imposed in the act would give a fair warning of danger arising in the usual conditions of mining. In the case of mines naturally damp, and decidedly free from gas, permission was also made in the act that any local and temporary detection of gas would not exclude the use of powder until it became evident that the increased proportion of gas was likely to prove permanent.

It must also be remembered that explosives play an important part in mining in addition to their employment for loosening the coal. Faults have to be penetrated, often through stone, tunnels must be driven to connect seams, roofs and pavements have to be removed, etc. These operations when expedited by the use of gunpowder or high explosives, have frequently proved very dangerous, and the source of serious explosions in the presence of gas and dust. So much is this the case that there is evidence tending strongly to show that, in haulage planes containing much dust, and presumably almost entirely free from gas, shots fired to bring down portions of a stone roof have caused disastrous explosions. Still such operations are essential to working coal mines, and their cost would be enormous if they had to be performed by manual labour only.

* Report of the Nova Scotia Explosives Commission.

Upon a careful consideration from every point of view of the difficulties surrounding the problem, it appears that the total prohibition of explosives would be almost impracticable, and result speedily in the closing of mines already compelled to use every economy to make both ends meet in the face of competition.

Under these conditions the importance became evident of ascertaining if there was any explosive that could be safely used in the presence of gas and dust, in order that the exploitation of the Provincial mines might not be injuriously affected. The International and Acadia collieries, in Pictou County, had for some time used Roburite, at first imported from England, but afterwards supplied from a branch factory in Halifax, working under the company controlling the patent in Canada.

The commission appointed to enquire into the subject, under the provisions of the act already referred to, comprised the Inspector and several mining engineers and practical miners familiar with the three principal mining districts of the Province. The Commission met several times at Stellarton, in Pictou County, and experimented in the collieries of the Acadia Company, and appointed a sub-committee to experiment in Cape Breton.

The general value of the explosives tested before the Commission at Stellarton, may be gathered from the following selection of experiments, conducted under the supervision of members of the Commission.

Two parties submitted explosives. The Acadia Powder Company of Halifax, which had been for some time engaged in the investigation of flameless explosives suitable for use in gaseous mines, produced two grades of a dynamite explosive, claimed to be rendered flameless by the addition of certain chemicals. As the explosives were experimental, it was not deemed necessary at that stage to consider their percentage composition. The Roburite Company submitted Roburite as manufactured by them at Halifax, giving its composition as 18 per cent. of chloro-dinitro-benzole and 82 per cent. of nitrate of ammonia. It may be remarked that the secretary of the English company intimated later that the compound as manufactured there did not contain over 12½ per cent. of chloro-dinitro-benzole, and that presumably it was made in Halifax of the same strength. The commission up to the date of its preliminary report, has dealt with the question of exact composition of explosives only in a general manner.

It may be remarked that in these experiments, the shots were fired with detonators, ignited by a victor battery.

1st Experiment.—Two 6 oz. cartridges of roburite were placed on the ground on the same wire, aud covered with a few shovelfulls dry slack coal. Both shots gave a short bright flash.

2nd Experiment.—One 6 oz. cartridge of grade "B," and a 3 oz. cartridge of grade "C," of the explosives of the Acadia Powder Company, were connected to the same wire, placed on the ground and covered with slack as before. On firing there was a flash from grade "C" cartridge, but none from grade "B" cartridge.

3rd Experiment.—A 4 oz. cartridge of roburite, covered with four inches of slack coal, gave a flash on being fired.

These experiments were made on a dark night, and as far as possible under the same conditions.

The tests were continued in the McGregor pit of the Acadia Coal Company. A number of holes were bored in firm coal, in the high side of the level, in a five foot seam, about half way between the roof and floor. The holes were three feet six inches deep, and from 1½ to 1¾ inches in diameter.

1st Experiment.—Charge 7 oz. explosive "B," hole tamped with clay for 25 inches. Shot blew the outside tamping off for a depth of 18 inches. No light visible.

2nd Experiment.—Charge 4 oz. roburite. Hole tamped with clay for 20 inches. Shot blew out tamping. No light visible.

3rd Experiment.—Charge 4 oz. explosive "B," hole tamped with clay for 20 inches. Shot blew out tamping. No light visible.

4th Experiment.—Charge 7 oz. explosive "B." No tamping. Shot gave bright flash.

5th Eperiment.—Detonator of Acadia Powder Company fired outside the hole alone and uncovered, gave flash.

6th Experiment.—A 4 oz. Cartridge explosive "B" with detonator in rear of cartridge, and pushed in the back of the hole, gave slight flash on being fired.

In the opinion of those witnessing these experiments, the flash observed when the explosives were fired, without tamping, was not greater than that due to the detonator, except perhaps, in the case of the fourth experiment in the McGregor pit. It is probable that the greater or less amount of flash visible in a number of experiments, may be due either to a lack of uniformity of the explosive mixture, or to the detonators not occupying, in each case, the same position in the cartridge. The fact was evident that the explosives, fired unconfined, did not give a flame, but a very brief flash of light. The blown out shots did not flame, nor did they give a light, a very slight tamping being apparently enough to delay the progress of the explosion long enough for the flash to have disappeared, when the rupture of the enclosing matter took place. It may be imagined that the sudden compression of the air in the vicinity of the charge might produce visible heat, in a manner parallel to the ignition of gunpowder by sudden compression of air in a cylinder.

Numerous practical experiments were made in this pit, substituting the new explosives for gunpowder in the ordinary working of the coal. These showed that as soon as the workmen understood the changed methods of apportioning the charge, tamping, etc, they got equally good practical results. As a specimen the following memo gives the particulars of a shot fired in one of the regular working places of the McGregor pit.

Working place 15 feet wide. Bench 6 feet by 7 feet, by 3 feet 9 inches high. (1575 cubic feet.) Hole 5 feet deep, 2 feet 6 inches from the higher side (the seam dipping about 1 in 3) level, and on bottom of seam. Charge 18 oz. "B" Explosive. First half of hole stemmed with clay, rest with slack coal. The shot was satisfactory. Coal hard and compact, and the bench had a layer of stone on top 9 inches thick.

The committee appointed to experiment in Cape Breton coals, which are softer than those of Pictou, reported that, in spite of their meeting with objections on account of cost, and prejudices in favor of the long established gunpowder, their opinion was that these explosives could readily replace gunpowder in that district.

At the close of the year the Commission submitted a preliminary report to the Governor-in-Councll, in which they state that they had selected two of the explosives submitted, as apparently safe and adapted for coal mining, and that they had confined their enquiry solely to the question of safety in blasting, but had not gone into the question of cost, or of safety in manufacture, transportation, or storage, and that no investigation had been carried into the composition of these compounds pending the results of certain changes recommended by the Commission as calculated to render them safer.

The Commission recommended that any of the four explosives, approved of by the French Minister of Public works, August 1st, 1890, be allowed to be used, and any other explosive, not yielding as the product of its detonation any combustible matter, such as carbon, nitrogen, etc., or having its temperature of detonation higher than 1500° C. if employed in coal blasting.

Recommendations are also made as to the proper length of tamping. Arrangements were made for the issue of licenses to manufacturers, testing of samples, firing by electrical fuses by low tension electricity etc.

Since the report was made, samples of ammonite have been received from England. This explosive is put up in thin metallic cartridges to prevent the action of moisture on the nitrate of ammonia. The explosive, which is highly spoken of in England, is likely to prove expensive, where it comes into competition with other explosives, which can be supplied to the miner fresh from the factory, if not as well protected from dampness. Opportunity has hitherto been afforded only of testing this explosive in Cape Breton, and the results were not conclusive, but further tests will be made in Pictou County, where more experience has been gained in handling new explosives.

The Acadia Powder company have improved their explosive, and are experimenting with an addition which has, it is claimed, the power to effectually waterproof their ammonia nitrate. Their new compound is substituted for the grades "A" & "B" referred to in this paper. The compound contains under 20 per centum of dynamite, and has in addition to the nitrate of ammonia, a chemical, which, stable in itself, is calculated to neutralize any trace of acid that may be present. So soon as the changes in the explosives are finished, the Commission will probably resume its work, and it is hoped will be able to recommend, at least two explosives superior in safety to any yet introduced in England or on the Continent.

NOTE.—The final results, analyses, etc., will be shortly submitted.

Discussion.

Mr. T. C. Brainerd said Mr. Gilpin's paper is a comprehensive and interesting account of recent efforts to obtain improved and safe explosives. Nothing can be more important than to find some method of mining coal that will avoid the terrible catastrophes hitherto incident to that industry. Great progress has been made already, as statistics prove, and the present discussion in all countries shows continued appreciation of its value.

Fortunately many mines are now successfully worked without explosives, but even when the position and character of the vein pemit removal of the coal by mechanical means, some blasting is generally necessary for sinking shafts, overcoming faults, and other purposes. The chief objection to the use in the coal of the modern nitro-compounds is that the force developed by the molecular change of their ingredients is not uniform, and is therefore unreliable as compared with the gradual combustion of gunpowder, which can be accurately measured and controlled. The expansion of the former depends on physical conditions, which vary in each case according to the pressure, temperature and other circumstances. Thus an explosive which, from its low specific heat or because the inner gasses are blanketed by a cooler envelope, shows no flame when burned in the open air, may develop brilliant combustion under the pressure produced by heavy stemming or other cause. Most of the "smokeless powders" have very little or no strength if fired in our Canadian winter when the thermometer is much below zero, but the same cartridge, allowed to remain in the chamber of a gun that has been heated by rapid firing, may shatter the barrel itself. The special means used for ignition also have great effect on the character of the explosion, the real discovery of Nobel, which made nitro-glycerine and dynamite useful, being the employment of the "Detonator." One of the "flameless powders" which has been most vaunted requires a detonator charged with no less than 23 grains of fulminate of mercury, an amount quite sufficient to explode even a very sluggish mixture of air and fire damp, and therefore an obvious source of danger. The electrical condition of the atmosphere modifies greatly these chemical actions. The mysterious and much discussed Elmore explosion was accounted for by one witness, an old mine viewer, as the "result of a tremendous lot of electricity in the air that night," but the explanation was not followed up by the Commission, although Mr. Chamberlain was its chairman and Lord Rayleigh one of the members. Yet the manufacturers of gunpowder in America learned long ago to close their mills on the approach of a thunder storm, not from fear of the buildings being "struck by lightning," but because experience proved that the air in the houses, charged with carbonaceous and oxygenated dust, would explode at such a time from a very trifling cause, that would have no effect in other states of the atmosphere. Some so-called safety compounds are as sensitive to shock under certain electric conditions as are Konig's flames to the musical note of the organ. In fact, all explosions may now be considered as rythmic motions, and there are probably few intimate mixtures of suitable ingredients that would not be promptly combined with detonation, if we could ascertain and produce the proper key-note. The object of the present study of the question is to avoid creating this exciting motor cause in coal mines.

Beyond the uncertainty as to what the resulting explosion will really be, there are economic and practical objections to many of the proposed substitutes for gunpowder. Some are liable to internal chemical change, extending even to spontaneous explosion when subjected to the climatic extremes of such a country as Canada. Others, like the compounds containing nitrate of ammonia, are deliquescent and alter rapidly in a damp atmosphere. Some, on burning, yield noxious or even deadly gasses, the coroner's jury having in March of this year given the fumes of roburite as the sole cause of death of a miner at Wigan. All are much more expensive than gunpowder, adding a considerable amount to the cost of each ton of coal, and many break the coal so fine as to create a further loss from the dust and slack. Finally, nearly all require an expert to properly use them, while the ordinary miner is reasonably familiar with the safe handling of gunpowder.

Concerning the latter, one decided source of danger comes from an excessive quantity being employed. Most mine operators sell the powder to their men, at a profit, and therefore think they have no interest in limiting the amount consumed. Hence the drill holes are generally overcharged, causing a volume of flame at each blast that could be entirely avoided. It should also be remembered that all European experiments and comparisons are from gunpowder made from nitrate of potash, while on this continent nitrate of soda is used almost exclusively for blasting purposes, giving a very different result in temperature of ignition, specific heat and amount of flame.

If any substance can be found that by its combustion or otherwise will develop enough controllable force to promptly and cheaply dislodge coal and other minerals without producing such heat or shock as to inflame fire damp, the world will be a great gainer. It has not been done yet. Many who have investigated the subject thoroughly and without prejudice think that ordinary gunpowder is safer than any thing so far produced. In gassy mines the use of any explosive should be very limited, and should be in the hands of a competent blaster, who fires the holes by electricity and between shifts, that is when all the men are out of the workings.

MR H. S. POOLE, said: As regards the practical application of flameless explosives a little may be said. When compressed lime was so much talked of in England some years ago trials were made with it here, but the results were not considered sufficiently encouraging to continue them. Two years ago in one of the pits, under the writer's charge trials were made of Sir F. Abel's water cartridges, but so much time was taken up in the preparation of each shot that it was felt they would not suit for general use in such cases as are here, in which as many as three shots a day may be required for each working place. The shots necessarily being under the supervision of specially appointed shot firers, where a large number are fired they would entail the employment of so many extra officials at a very heavy increased cost. Besides it was evident that a comparatively large number of cartridges might lose their included water so that the search for safety in that direction was abandoned.

Trials would also have been made with such compounds as carbonite could they have been obtained otherwise than by importation from Germany; but not being available, applications were made to the local factory of the Acadia Powder Co., and a compound was prepared which when tried in April, 1890, was, with respect to flamelessness, found satisfactory. Practical difficulties in other directions stood in the way of its general use at that time, and it was not until 1891 that opportunity was had for trial and subsequent use flameless mixtures from the same company and from a branch of the English Roburite Company.

Opposition to the introduction of these explosives was raised by the miners, for a life long experience with black powder had familiarized them with its capabilities, and they objected to the price and the fumes of the modern explosives. The complaint about fumes is no longer heard, many men contending they mind them no more than the smoke of powder, and with the worst of the explosives by keeping away from the seat of the shot for a couple of minutes, no inconvenience is felt,

As to price, the miners who have learnt to proportion quantity used to the work to be done have accepted the gain when the shots are successful, and the loss when misfires occur, and shots are lost.

All these explosives require detonation to make them efficient, and the electric fuses necessary are comparatively costly and doubly so when the shot fails to accompany the detonation of the cap. When this occurs the charge sometimes burns in the hole without exploding, and almost invariably so quietly that no sparks or flame are seen to come through the tamping. But we had one shot out of some twelve thousand that had been then fired with one of these mixtures, that, burning, only showed sparks but no flame, at least so the shot-firer and a miner contended, and the writer does not question their veracity. At the same time he has no reason to believe that the sparks so seen were of such a nature that they would have fired gas had it been present in quantity.

The introduction of these "flameless" explosives is to endorse one great element of danger in coal mining. Common powder does the work required of it in coal well, it sends from the working face great blocks little shattered, if the shot has been, as the miners say, "properly worked;" while all the high explosives and many of the flameless variety have a local shattering action which largely increases the percentage of slack produced, and thereby seriously affects the profits of the mine; the market value of large and small coal differing very considerably. There has for a long time been recognized the danger attending the use of black powder in pits of a certain character, and the Legislature has imposed restrictions on its use, but the immunity of accident in some mines freely producing gas, and in which millions of powder shots have been fired without disaster, also shows that there are conditions when the use of powder is reasonably safe. The line of safety is a debatable one, but the disastrous side is now generally considered to be where there is fine dust. Not that the dust itself is generally regarded as likely to start an explosion, but that it keeps up an explosion which a cap full of gas may have started, and which alone in a damp pit would have done no damage. To lay the dust, watering has been practiced, but this cannot be done thoroughly in some mines, as for instance where the coal itself is so dry that the working at the face creates a cloud of dust, and where also the roof is broken and timbered, and so offering lodgment for dust in places impossible of access. On account of dust the writer abandoned the use of powder in one pit four years ago.

The writer said that he lately had the honour of reading before the Mining Society of Nova Scotia, a paper† on this subject in which the advantages and difficulties attending the introduction and substitution of "flameless explosives" for common black powder in the mines he had to do with were enumerated. He did not consider, therefore, that the present occasion called from him even a partial repetition of the experience therein related; he thought there was, however, one point introduced by Dr. Gilpin which would yet require legislative reconsideration, and that relating to the test defining what was a fiery mine.

The safety lamp test which drew the line on the appearance of a blue cap in the presence of inflammable gas could now hardly be considered a fixed standard, for it not only was subject to "personal error," but now varied with the style of lamp used, some lamps of modern construction being more sensitive than the Davy or even the Mueseler. The spirit lamps of Peeler and Ashworth detecting percentages so low that atmospheres carrying them have been, and even now are by many considered safe to work in.

For his own part he contended that the danger arising in mines from the emission of fire damp was not in proportion to the percentage of gas evolved regardless of other conditions, but that it was largely governed by the hydroscopic state of the air. A free evolution of gas, readily to be both seen in the lamp and heard issuing from the cracks in the coal of a damp mine was not to be dreaded to anything like the same extent as a much smaller quantity that imperceptibly escaped into the atmosphere of a dry and dusty pit. He goes further than Dr. Gilpin, and says that "gunpowder has been continuously used for years with impunity in the presence of" not minute percentages, but large percentages of gas in damp mines, and therefore he is disposed to contend that as it is a general maxim that legislation should interfere as little as possible with trade, all mines showing gas should not necessarily, therefore be subject to the closest restrictions, provided that the hydroscopic condition of the air is at no time disregarded. In thus questioning the necessity and advisability of sweeping enactment to which popular clamour flies for relief when sudden disaster excites attention he ventures to do so as one whose past ought to enable him to speak with experience; he has to do with mines where it was mentioned before a Royal Commission in 1835," "gas issued with the hissing noise of ten thousand snakes," and in his practice was the first to introduce in Nova Scotia, improved forms of safety lamps and to see the advisability of entirely giving up the use of powder in a dry mine. His surprise is not that disasters do sometimes occur, but that they occur so seldom.

†Printed in the CANADIAN MINING REVIEW, July, 1892.

He does not consider the clause in the present Mines Regulation Act‡ respecting the use of explosives where gas is occasionally found as sound. It makes the inducement for an imperfect test very great, for example to stop the test six inches of the roof, when in the last six inches the probability of finding gas is greatly augmented; or to send ahead of the gas trier a man with a bag to beat and disturb the air at faces where gas is most likely to accumulate. He believes in legislative recognition of the modifying influence of moisture and in the intensifying of danger in dryness, he agrees with Dr. Gilpin in regarding mines of his second class, occasionally producing gas as proportionally more liable to accident than mines recognized as "gassy." But to avoid misconception he desires to add that not only is he an advocate for the so called flameless explosives as reducers of danger, but that he began their use prior to their consideration by the Legislature. As an illustration of the extent to which gas is given off, he would mention that a pair of leading places in the deep seam at Stellarton, N.S., produce 180 cubic feet per minute and that the evolution is constant.

MR. GILPIN in reply said he would remark with respect to Mr. Brainard's example of the deadly fumes of roburite, that practical trial has shown that in a properly ventilated coal mine its fumes are not objected to by workmen. And the same is the case with the flameless powder of the Acadia Powder Co. If a moment be allowed for the fresh air to mix with the fumes no ill effects can be noticed. The miners, when they are once initiated, as a rule, find little difficulty in adopting the new explosives. No gold miner now raises any objection to using dynamite. Whatever may be the weight of opinion of individuals as to the percentage of safety of gunpowder over that of the so-called safety explosives, it is conceded that the thorough and unprejudiced examination of the subject by several European governments has resulted in very emphatic repudiation of gunpowder in the presence of gas or dust. With regard to the definition of a gassy mine it may be said no two mines are alike, and the adoption of a "Plimsoll" mark is difficult. The dampening of the air currents is a great safeguard as suggested by Mr. Poole. But in many large and deep mines it would be attended with much expense. It may be remarked on Mr. Poole's statement that the classification of mines as adopted by Provincial legislation makes a great inducement for imperfect examination, is hardly just. No legislation requiring dozens of men daily to do certain things under ground, out of sight, and not before witnesses, can be enforced unless the gas examiners and their employees choose to recognize the fact that the law is one instituted for their safety, and they act as honest men. The writer thinks most mine bosses would hesitate to suggest to a gas examiner that he slur over his work if he reflects that such a course might lead to his being indicted for manslaughter.

Failure of Winding Ropes in the Dortmund District —Nearly the whole of the winding ropes used in the Dortmund district are of cast steel wire. In 1890, 187 round ropes and 45 flat ropes were renewed. Ten of the flat ropes and 19 of the round ones had been in use for less than 200 days, while nine of the round ropes had lives exceeding 1,000 days. Only six of the flat ropes lasted more than 400 days and none more than 1,000 days. Of the five ropes which broke in 1890, four were flat ones.

The Manufacture of Briquettes.

Some notes on compressing brown coals into briquettes are given by Mr. B. Straube, in the (Annual Report for the Secretary of Mines, Victoria, 1891, pp. 49-52, one plate.) The principal point in the manufacture consists in the proper selection of the methods for drying and heating the coal before it is compressed. Unlike other coals, brown coal contains enought bituminous material so that admixture with pitch or other binding material may be omitted; but as the constitution of coals from neighboring districts varies greatly, very careful selection of the methods and machinery is requisite. The processes are considered under three heads:—

Crushing the raw and wet coal.

Drying and heating the crushed material.

The compression of the brown coal into briquettes.

Crushing is best performed between a pair of rolls—one plain, the other closely fluted. The crushed material is passed over an inclined sieve, or over two if the material is fibrous, as it is essential that large pieces be removed. The coarser material is re-crushed or is used under the boiler. The crushed coal is then taken by conveyors to the drying stoves, where the water is reduced about 35 per cent. down to 15 per cent., which is found to be a suitable amount. As a rule, highly bituminous coal contains less water and requires a lower temperature to dry it. The ovens which have been adopted may be classified under five heads, namely, those drying by (a) fire-gases alone, (b) steam only, (c) hot air only, (d) hot air and steam, (e) fire-gases and steam. Examples of each of these types of ovens are described and illustrated. A recent improvement is the use of a large re-heating chamber, in which the coal from all the ovens is collected and re-heated. Some coal indeed requires a second crushing and sifting before it is re-heated. The ratio of compression varies with the coal, but averages 45 to 50 per cent. The author concludes with an estimate of the expense of compressing brown coal in Victoria, the Gippsland coal being employed.

‡"And may order that the use of any explosive is obligatory under this rule only if inflammable gas is found in two consecutive days on any two consecutive weeks." Sec. 24, chap. ix., 1891.

Peat Charcoal and Bog Ore.

By Walter J. May. *

The success which has attended the conversion of peat offers an opportunity of reducing bog iron ore in places where coal is not readily obtainable, and although probably some trouble would be experienced in the earlier part of the business owing to the form in which the charcoal would be presented, there is no reason why this should not be soon overcome. If necessary, the charcoal could be compressed to secure additional value in the furnace, but as the furnaces would be comparatively small, the burden would not be so great as in a coke furnace. The iron would probably be of excellent quality, and would thus make some amends for any additional cost incurred. As probably the ore would be fairly free from slag-producing materials) limestone or other fluxing agent would only have to be used in small quantities, thus reducing one element of expense, and probably the working would eventually cost no more than that of an ordinary charcoal furnace.

Speaking generally, peat charcoal would lack both the size and hardness of live oak and other wood charcoals, but it would not possess much more impurity unless the peat beds were charged with layers of earthy minerals or deposited silica. It might be found necessary to use larger quantities of peat as compared with wood charcoal to secure the same results, but as the peat can be very cheaply converted, this would make but little difference, difficulties being more of a mechanical than a financial character.

The ore would be cleared from mud and would also be of a fair size, or, more correctly, an admixture of sizes, and the separation from mud and the finer matters would be very simple. In fact, by following the method adopted at Lac-à-la-Tortue, near Quebec, it should be quite possible for anyone interested to design simple washing apparatus for the purpose. At Lac-à-la-Tortue the ore occurs in the greenish mud, and in the sand underlying the mud in the lake bed, and the water having been lowered some 7 or 8 ft. recently, the ore in the exposed portion is worked by hand, while that under water is lifted by a chain dredger having three rows of buckets. The ore, which is in the form of irregularly round flattened masses, varies in size from the size of shot to that of concretions several inches in diameter, and that extracted by hand is washed clear of mud in hand sieves of suitable mesh, the process being somewhat similar to sand washing as adopted by plasterers in this country. The ore, and mud, or sand, lifted by the dredger is discharged into a revolving sieve set at an inclination, and along its axis a series of jets of water are arranged, and these wash the ore clean, the washed ore passing direct into scows alongside, and in these it is taken to one end of the lake, and from thence conveyed by rail to the furnaces at Radnor.

The process of cleaning is not only simple, but also effective, and there is no reason why the same method should not be adapted to other than bog ores, where they are suitable for such simple treatment. It is, however, necessary in any case that the screen be of sufficient strength, and that water be at hand in adequate quantities. Where the ore is free from adhesive matter and it is not desired to secure the whole of the finer particles of ore—and these are usually the richest in metallic value—then a revolving perforated screen appears to be far more suitable than the hooded barrel or cylinder, as less weight has to be revolved, while cleaner work should be produced if the axil water jets are properly arranged, and a screen having as small as 3 mm. round perforations should work well without choking. If built of plates about 4 ft. long and properly carried on friction rollers, there should be little difficulty in working a screen of some considerable length, but it must always be remembered that the smaller the perforations the thinner the plates, and as the thickness of the plate must be less than the diameter of the perforations some kind of strengthening would have to be used with very fine screens, particularly as they wear thinner and become less able to withstand torsion.

The way in which bog ore is formed is both curious and interesting, and although probably slightly varying in different localities, practically—although not actually—the process is the same everywhere. The water, owing to the decay of vegetation, becomes charged with acids, and these dissolve out the ferric oxide from the sand through which the water percolates. The water and the contained proto-salts of iron rise to the surface of the pools or other comparatively still waters and become oxidised, the salts of iron becoming insoluble, and are then precipitated to the bottom, where they form concretions round nuclei of some other material. Successive layers of the oxide form around these, and hence they become larger. In some instances it will, however, be found that the successive layers of oxide are not produced, but that the form taken is that of a fine granular powder, while in others the oxide and gravel concrete together in masses, and in this state the amount of siliceous matters renders the ore useless for smelting.

Possibly, also, oxygen is formed in some of the strata under the water, and as it escapes, exercises an amount of oxidising force on the ferric salts in the water, and this leads to the formation of concretions of ore in positions not otherwise favorable. It is certain that this ore is continually being formed, as places in the Lac-à-la-Tortue—places which were exhausted some eight or ten years since — now yield profitable quantities again. Whether this rapidity of formation is a general thing the writer is unable to say from personal observation, but provided the conditions are favouroble, there is no reason to doubt that such is the case.

Taken altogether, the possibilities in regard to the utilization of peat and bog ore in the production of charcoal iron are good, provided the mechanical difficulties in dealing with the peat charcoal are overcome, and in this respect it appeats to the writer that a very little amount of experimental work would be found necessary, as the burden to be borne would not be very great comparatively. The matter is one for investigation, and in many places this can be done at a small expense.

* Colliery Guardian.

Patent Fuel Machinery.

By Dr. C. M. Percy. *

What shall we do with our Small Coal?—This is a question which has attracted a great amount of attention in the United Kingdom for many years, and as time goes on the amount of attention will certainly increase. The percentage of small coal is considerable in most mining districts, and very serious in some; there are, of course, exceptions, and the writer of these notes was consulted, a few months ago, as to coal breaking machinery for the purpose of reducing the size; such machinery is largely in use in the United States of America. With us at home, however, coal requiring machinery to reduce it in size is exceptional, and our trouble is the amount of very small coal, amounting to many millions of tons a year. Every ton of this small coal costs as much to produce as round coal, but, as everybody knows, it sells for a great deal less, and in the majority of cases at less than the cost of production.

The proportion of very Small Coal will not Diminish.—The proportion of very small coal will certainly not diminish with the increasing depths of the mines that we shall have to work, and anything which will tend to increase its marketable value will be beneficial to the mining industry. A very large quantity of small coal is consumed every year in coke manufacture, for which purpose the small is not only not inferior, but expense is incurred in crushing or disintergrating the coal almost to dust. The smaller the size the better for coke making, and the more uniform the quality of the coke produced.

The great trouble with Small Coal.—The great trouble with small coal is the amount of dirt intermixed with it; this has to be removed, otherwise the coal will practically be valueless. Our mining friends on the Continent of Europe were forced by circumstances to take this matter in hand long ago, and consequently are much ahead of English collieries in the cleaning and assorting of coal; they have been suceessful in raising the process to the dignity of an art. Latterly, in the United Kingdom we have followed suit, and in many of our mining districts we now have elaborate plants for freeing small coal of its impurities, and sending it into the market in sizes suited to the various requirements. This kind of thing will increase, and it is not improbable that the coal industry will find salvation in the cleaning and sizing of small coal.

Every quality of Coal will not make Coke.—But every quality of coal will not make coke, although by the more modern methods of coke making really good coke is produced from coal which the old fashioned arrangements were not capable of dealing with; and even coal unsuitable in itself is now producing good coke when mixed with other qualities of coal. Still, with all this we have millions of tons of small coal raised each year which cannot be used in coke making, and which, sold in the raw state, scarcely pays for carriage.

Briquette Manufacture has stepped into the Breach.—Briquette manufacture has stepped into the breach, and by utilizing the very smallest of the coal in the form of briquette or bricks it can be conveyed any distance by sea or land without crushing and without loss, and for domestic and other uses serves as well as round coal. The briquette process is not new, having probably been practised, more or less, for nearly half a century.

The Briquette Process often a Failure—It has been tried in different places by different people, and often failure has been the result; sometimes the coal was unsuitable, and sometimes the machinery was imperfect. The writer, during a visit to the Yorkshire coal-fields a few years ago, was shown a briquette which was said to have cost its owners thousands of pounds.

Successful Briquette plant at Uskside.—Success has, however, come to some who have tried the process, and during the period of the last Glasgow exhibition, at least one firm in Scotland was doing a very good home and foreign trade in coal briquettes.

The Briquette Process.—Usually in briquette making there is a combination of coal and pitch (we say usually, because there is an arrangement which lately came under our notice, no pitch was used), and in the machines the coal and pitch, after having been ground and mixed, enter the Pugmill. The Pugmill is supplied with steam-jets, and the coal and pitch are there thoroughly mixed, and the pitch melted, and thoroughly incorporated with the coal, thence it falls into the feeding pan, and from there falls into the moulds of a revolving table which passes underneath. At a certain point in the travel of this table steam is continually admitted to the steam cylinder, and great pressure is brought to bear upon the coal contained in the moulds. Each mould carries its own piston with it, and consequently there is no necessity for the table to stop at an exact point, which is always a great difficulty with machines dealing with rough materials. The coal in the mould, after being pressed, is gradually pushed out of the mould by means of a piston travelling up the incline plane, and is then delivered either into wheelbarrows, or, preferably, into an endless band, as may be arranged. The Uskside Engineering Company have the advantage of being well within the range of the great industrial district of South Wales (being situated at Newport, Monmouthshire), which is eminent for the adoption of improvements in coal production, and in iron and steel manufacture.

South Wales the Home of the Briquette Manufacture—By its extensive adoption of these appliances, South Wales has almost earned the name of the home of the Briquette manufacture, and at one time practically exported the whole of its production. Latterly a good deal has been used for domestic purposes at home, and there is no valid reason why other mining districts should not endeavour to emulate so good an example both in export and in home consumption.

The Briquette Plant Varies in Power—The Briquette plant varies in power and in the quantity capable of being produced; some machines making as much as 400 tons a day. The Briquettes also vary in size from a minimum of one pound in weight to as much as 15 pounds.

Recent Improvements in Briquette Machinery—The most recent improvements in Briquette machinery include small, self-contained plants, capable of making about six tons per day of ten hours, in Briquettes weighing one pound each. These machines are specially designed for the use of large coal merchants, who, in the course of their trade, have a quantity of unsaleable small coal to deal with. It has been a pleasure to the writer to describe so good a type of machinery for so useful a purpose, namely, increasing the value of small coal.

The Uskside Engineering Company—Some years ago it fell within the writer's duty elsewhere to describe another arrangement, equally as good, of the same class, by the same firm, the object being to lessen the consumption of coal in the operation of colliery winding. We refer to the application of automatic expansion gear to colliery winding engines, by which a saving of 25 per cent. of coal consumed for steam generation has been effected.

* The Science of Art in Mining.

Preserving Wire Ropes.—For the purpose of a protecting coating for wire ropes which are laid on the ground or which come in contact with water, a mixture of thirty-five parts of slacked lime and sixty of tar is recommended. This mixture is boiled and the rope painted with the hot mixture. Linseed oil and vegetable tar or grease with graphite form good paints for dry-lying ropes.

Endless Rope Haulage.—The endless rope system of haulage, which has displaced the single rope-system at the Mitchell main colliery, is described by Mr. T. W. H. Mitchell, in the *Transactions* of the Federated Institution of Mining Engineers. At this colliery the Barnsley bed is worked on the long-wall system, at a depth of 307 yards. The engine is placed on the surface and runs at nineteen to twenty revolutions per minute, and drives the rope at about 50 yards per minute. The rope is 1¼ inch in diameter, and is wrapped three and a-half times round a taper drum 9½ feet in diameter. Trucks are attached to the rope by chains 12 feet long, one end being hooked to the drawbar, and the other end wrapped twice round the rope, and the hook brought across the chain when extended. Catches and means for returning the vehicles to the rails are fixed every few yards, and a guide-rail is fixed between the two tracks to prevent the full trucks from fouling the empties.

The Manufacture of Patent Fuel.—According to Mr. J. Clark, in the *Transactions* of the Mining Institute of Scotland, the first recorded attempt to introduce the manufacture of agglomerated fuel into England was in the year 1594, when Sir Hugh Platt published a work entitled, "A New, Cheap and Delicate Fire of Coal Balls." He describes his project as one to sweeten sea-coal, so as to make it a substitute for wood in domestic economy, by mixing loam with the pulverised coal. There are about 385 specifications relating to patents for inventions of artificial fuel made from small coal between the years 1799 and 1885, and of all the materials tried, pitch remains the only one in regular use.

At Ormiston Station colliery a small plant for the manufacture of patent fuel was erected two years ago, and is described in detail by the author. The coal and pitch are ground together in a disintegrator and are stirred and heated to the proper consistency for compression in a pug-mill. The mixture is received in a pan-mill with revolving arms in it to fill the moulds, and the blocks are compressed in a press cylinder under a pressure of 12 cwt. to the square inch of block surface. The whole of the machinery is driven by a pair of coupled engines with 10 inch cylinders and 20 inch stroke, supplied with steam at 40 lbs. pressure. The speed of the engine is 60 revolutions per minute, and that of the main shaft of the full plant is 95 revolutions per minute. The machine turns out three tons of fuel per hour, the quantity of pitch used being 9 to 10 per cent. of the finished fuel. The size of the briquette made is 6 x 4 x 3⅝ inches, and its weight is 4 pounds.

New Glasgow Iron, Coal and Railway Company—Description of the New Works at Ferrona.

The actual work on the plant of this company commenced in April, 1891, a great deal of preliminary work had, however, previously been done; the plant was put in operation September, 1892. The works comprise the following departments:—

1st. A complete railway system, connecting the ore and stone quarries with the furnace plant, and with the I. C. R. R. at Ferrona Junction.

2nd. Numerous ore mines, limestone quarries, ore washers, etc.

3rd. A complete coal-washing plant.
enclosed.

4th. A complete coking plant.

5th. A complete blast furnace plant.

The ore and limestone is brought to the stock house on the company's own railway. This stock house is a large wooden structure, covered with corrugated iron, the size of the building is 91 feet in width, by 250 feet in length, thus giving a large floor space to store ore, limestone, etc. The ore has been washed before it is stored in this building. The coke used in the furnace is brought to the stock house from the ovens in the charging buggies, two of which are placed on a flat car pulled by an endless rope, these loaded buggies go right to the furnace, two empty ones being returned on the car to the coke ovens to be loaded.

Within the stock house are located the stock scales, on which all material (stock) going into the furnace is weighed.

The ore, limestone and coke from the stock house is now taken to the top of the blast furnace by means of a double elevator, located in an all iron hoist tower. The elevator cages are worked by an automatic hoist engine, located at the foot of the hoist tower.

The hoist tower is connected on top with the blast furnace proper by means of an iron bridge. The buggies, with material are dumped on the bell of the furnace, which is lowered or raised by the top-filler by means of an air cylinder.

The blast furnace proper is of modern design and fitted up with the most modern appliances. The clear lines of the furnace inside of the brick work are: Height, 65 feet; bosh, dia., 15 feet; dia. of crucible, 9 feet, 9 inches. There are eight tuyeres and two cinder notches located within the crucible.

In front and surrounding the furnace is the casting house, 50 feet wide, by 135 feet long, constructed entirely of iron. The pig iron is taken from this house on little cars to a scale located at the end opposite of the furnace. After being weighed the pigs are broken in half, graded into the different qualities, and stored in the pig iron yard ready for shipment.

The furnace has two downcomers (gas flues), one carries the gases to the hot blast stoves, the other to the boilers. There are three hot blast stoves, of the three-pass Massick and Crooke type, each stove being 16 feet 6 inches in diameter inside of shell, and 60 feet in height. There is also located a chimney on top of each stove, 4 feet in diameter by 35 feet in height.

Each stove is lined with about 160,000 fire bricks. The aforementioned downcomers bring the gases from the top of the furnace to dust catchers and gas washers located at the bottom, from here the cleaned gases are either taken to the stoves to heat them or to the boiler plant to raise steam. The air necessary to smelt the ore etc., in the furnace, is produced by two powerful blowing engines, each weighing about 90 tons. These engines have steam cylinders of 36 inches diameter, air cylinders of 84 inches diameter, and 4 foot stroke. The cold air leaves the blowing (air) cylinders of the engines under considerable pressure. It passes through an iron pipe 30 inches diameter, (cold blast pipe), to the previously mentioned stoves, while two stoves are being heated by the waste gas, the third stove receives the cold air from the engines, this air becomes very hot while passing through the red hot brick work of the stove, and is taken by means of a fire-brick-lined (hot blast) pipe to the tuyeres of the furnace, thus reducing the fuel cousumption very materially as compared with the old style furnaces, where the air from the engine is used cold.

The blowing engines are located in a brick building of very strong design. The building is 35 feet wide by 60 feet long, and 35 feet high below the roof truss. This building contains also two powerful boiler feed pumps, two feed water heaters and various steam, pressure and air gauges.

The steam required is generated at the boiler plant, comprising four double batteries of tubular boilers, designed to carry a pressure of 100 pounds per square inch. Each of the eight boilers is 6 feet in diameter, 20 feet long, and contains 52 tubes, each 4½ inches in diameter. The boilers are heated by the waste gases, the draft is produced by an all-iron chimney, 7 feet 6 inches in diameter by 125 feet in height. The chimney is lined with fire-bricks 4 inches in thickness.

The boilers are located in a wooden boiler house, with a tile covered roof; this house is 42 feet wide by 94 feet long. The water required is pumped by two powerful duplex pumps, from the East river direct, into an iron stand pipe (water tower) 10 feet in diameter, 80 feet high; all water used at various points of the plant comes from this stand pipe under a pressure of about 40 pounds.

The company also has a fully equipped chemical laboratory, where all ores, etc., are carefully analysed as far as necessary. Besides the afore-mentioned appliances, there are numerous other machines, etc., amongst them two complete ore washers, two locomotives, cinder cars, railroad cars, etc.

A large number of steam radiators, etc., are provided wherever there is danger of freezing in winter.

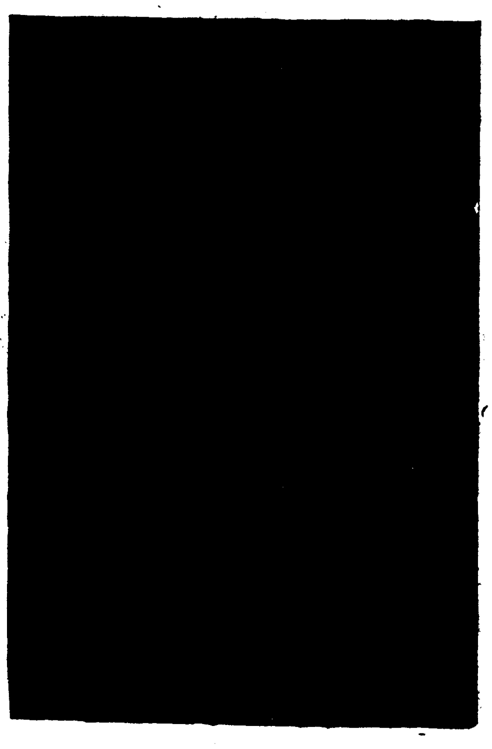
Coal Washing Plant—This plant was put in successful operation in May, 1892, and has been in constant operation ever since. The plant was built with the idea of washing the fine coal from various mines, the washed coal to be used for coke purposes. In connection with the coal washing plant, there is a retort coke oven plant of 54 retort coke ovens, having a daily capacity of about 175 tons of coke. The coke is pushed out with a special machine, a coke pusher. The attached drawing shows the general arrangement of the washing plant, C 127.

The coal from the various mines arrives on the railroad tracks A1 and A2, and is dumped into the pits B1 and B2 (a different kind in each pit). From these pits the coal is taken by means of bucket elevators C1 and C2, to the shaking screen D. This shaking screen has double eccentric motion, imitating hand screening as much as possible; the mesh of the screen is ⅜ inches.

The material too large to pass through the perforations drops into the crusher rolls E1 and E2, and is again taken after the crushing, to the shaking screen D, by means of the bucket elevator F.

The coal passing through the shaking screen D is taken by means of the bucket elevator G to the separating screen drum H, which separates it into three sizes: 0 to ⅛ in., ⅛ in. to ¼ in., ¼ in. to ⅜ in.

The different sizes are carried by means of chutes to the various jigs J to J8. These are all two-compartment feldspar jigs, arranged with variable stroke. Each screen compartment is 28 inches wide and 49 inches long, so that the coal must travel a distance of over 8 feet while being washed.



Mr. John F. Stairs, M.P., Halifax, N. S., President New Glasgow Iron, Coal & Railway Co.

The washed coal flows in gutters to the large elevator boot K2, and is elevated from there to the top of the storage tower by means of the perforated bucket elevator I2, which discharges the coal on the distributing conveyor M, which distributes it into the various compartments N of the large storage tower.

The two jigs shown in dotted lines, the elevator boot K, and the elevator I, are arranged to be put in if the plant requires enlargement.

The slate from jigs J to J8 is discharged into elevator boot Q, and is taken from there by means of a perforated bucket elevator R, and dumped into railroad cars ready to be taken to a convenient dumping place.

T is the centrifugal pump which distributes the required water. The water after being used always returns to the centrifugal pump and is used over and over again. There is no loss of water except that absorbed by the coal, and enough fresh water must be added to make up for this loss.

N is the steam engine of 100 h.p. to drive the entire plant.

The elevators are all of special construction and have very large buckets, and automatic feed, etc., and are run at a very low speed.

As will be readily seen the entire plant works automatically and consequently requires only three men to run it.

The coal washed contains from 17% to 35% of ash, besides in the neighborhood of 2½ to 3% of sulphur; the washed coal contains in the average 10% of ash or 1% more than the fixed ash (9%) of the coal. This is a remarkably good showing and is seldom equalled at any washery in existence. The fixed ash cannot be reduced by any method. Coming within 2% of the fixed ash is considered excellent work.

The sulphur is reduced by washing from 2½ to 3% down to 1·35%, the sulphur still left is organic sulphur and in combination with alumina or lime.

Jigs J to J5, was in the original plant; J6 to J8 were added when the additional retort coke ovens were built. The total capacity of the plant is now 300 tons of coal in ten hours.

Coking Plant—In addition to the coal washing plant, drawing C 127, already described, there is a battery of fifty-four retort coke ovens, Bernard's system (improved coppée).

Drawing C 149, shows the complete coking plant. The plan shows first: A side elevation of the ovens with section GH; second, a top view and sections A B, C D, E F, and K L; third, a cross section, M N, through the centre of the retort, and finally a cross section, O P, through the centre of partition wall between every two ovens.

1 marks the original battery of 36 ovens, built two years ago; 2, the eighteen additional ovens built in February last; 3 and 4 are the chimneys for each battery in case the surplus gases are not used for steam raising; 5 shows the place where the coke pushing machine travels parallel to the ovens; 6 is the coke discharge side; 7.7 are the tracks for door-lifting windlasses; 8, 8, 8 are the tracks for the coal charging buggies (lorries); 10, coke pushing machine (ram); 11, hydrants to supply the cooling water; 12, gas flue; 14, 14, 14, 14, cooling flues; 15, 15, 15, coal charging holes; 16, 16, air inlet valves, for the air necessary for the combustion.

General—There are 54 retort ovens in all, each retort (oven) has the following inside dimensions: Length, 33 feet; height 6 feet 6 inches (under roof); medium width, 23½ inches. Each oven (retort) is charged with about 7 tons of washed coal (all below ⅜ in. mesh) every 40 or 48 hours; the 54 ovens produce every 24 hours between 115 and 120 tons of first-class large coke, which is all used in the blast furnace of the company. The coal used yields 73 or 74% of large coke right along, the same coal only yields 60 per cent. max. in the bee-hive oven. Each oven can supply 130 to 150 square feet of boiler surface for steam raising if desired.

The ovens are built of the best quality of fire bricks obtainable, the composition of the fire bricks varies in the different parts of the oven and is specially made to meet the various conditions of heat, reducing cost of repairs to a minimum, away below those arising at bee-hive ovens.

Mode of Operation—Each two ovens work together and for this reason the ovens are charged alternately; one day the ovens 1, 3, 5, 7, 9, etc., uneven numbers are pushed, the next day the even numbers, 2, 4, etc., are discharged; this arrangement makes it possible to work a hot and cold oven together, utilizing the surplus heat of the hot oven to heat the cold (freshly charged) oven. After the process of coking is finished the doors at both ends of the respective ovens (retort) are lifted by means of the windlasses afore-mentioned, the coke pushing machine now pushes the whole cake of coke out of the retort, landing it clear of the ovens on the discharge side (6), where it is water-cooled.

As soon as the coke is pushed out by the ram of the coke pushing machine, the oven doors are re-closed and sealed air tight with ordinary clay; the coal to be charged is now dumped into the oven through the charging holes 15, 15, 15, and levelled in the usual way.

The main advantages of these retort ovens, without saving of tar and ammonia, over the bee-hive oven are as follows:—

1st. A larger yield, 12 to 15 per cent at least.

2nd. Considerable lower cost of coke-making (labor—expenses).

3rd. All coke produced is large and strong, there is less than 3 per cent. of fine coke—braize.

4th. Large production per oven.

5th. Fewer repairs, etc.

6th. One important advantage of the retort oven is that owing to the high temperature carried and to the high and narrow column of coal, (6 feet), inferior coking coals can be successfully coked, also a mixture of coking and non-coking coal.

The ovens of the New Glasgow Company are the first retort coke ovens working successfully on this side of the water.

On the continent of Europe the retort oven has entirely replaced the bee-hive oven, and England is at present building large numbers of retort ovens to replace bee-hives; in America also competition will no doubt force the coke producers soon to adopt the retort oven, either with or without saving of the by-products.

Ore Deposits.—As is well known, the ore occurs at the junction of the Carboniferous and Silurian formations, in bodies of large size, which are opened at different points in the East River, extending over a distance of five miles. The ore is won by shafts or inclines, according as the pitch of the ore is more or less inclined. During the past year the ore used has come principally from the McDonald and Grant mines. Tramways, as shown in plan, extend from the mines to the washer. The principal impurity in this ore is clay, which is easily and cheaply separated by washing. The washer used is a section of a conical revolving drum with inclined blades or fins on the inside, which work the ore from the large to the small end, while the water (from a Cameron pump) enters at the small end of the drum, washing the clay from the ore which it meets in its descent, and discharging it in spouts, which lead the settling pond. The ore is discharged from the sma end of the drum into a bin, and from thence into the cars.

The Cameron mine is situated about half a mile north

New Glasgow Iron, Coal & Railway Company, Ltd.

from the washer, and has not been worked so far, being kept as a reserve.

There has also been used in the furnace during the last few months a red hematite, which occurs in the Lower Silurian formation as bedded deposits. This is the same class of ore as is mined at Torbrook, Annapolis Co. It occurs in large beds in Pictou Co. and also at Arisaig, in Antigonish Co.

All the ore obtained so far has been from open cuts, no systematic mining having been commenced on this red ore. The amount of ore mined is about 4,000 tons per month, including both brown and red hematites.

Mining Machinery.

The machinery at the mines comprises:—

Grant Mine.—One upright boiler of 25 h.p.; one double cylinder; hoisting engines having cylinders 8 x 10; one Cameron sinking pump, 9 x 8 x 4, etc.

McDonald Mine—On Slope—One 60 h. p. locomotive boiler, and one 50 h.p. double cylinder Lidgerwood hoisting engine. On Shaft—One 60 h.p. hoisting engine (Jenckes) and one 12 x 11 x 5 Cameron steam pump.

Fraser Mine.—One 30 and one 15 h. p. upright boiler, one 16 h.p. double cylinder hoisting engine, one 8 x 6 x 4 Cameron pump, and one 7 x 8 x 4 duplex Worthington pump; also ore washer, operated by one 100 h.p. upright boiler, and one 15 h.p. single cylinder stationery engine; Cameron pump 10 x 8 x 4.

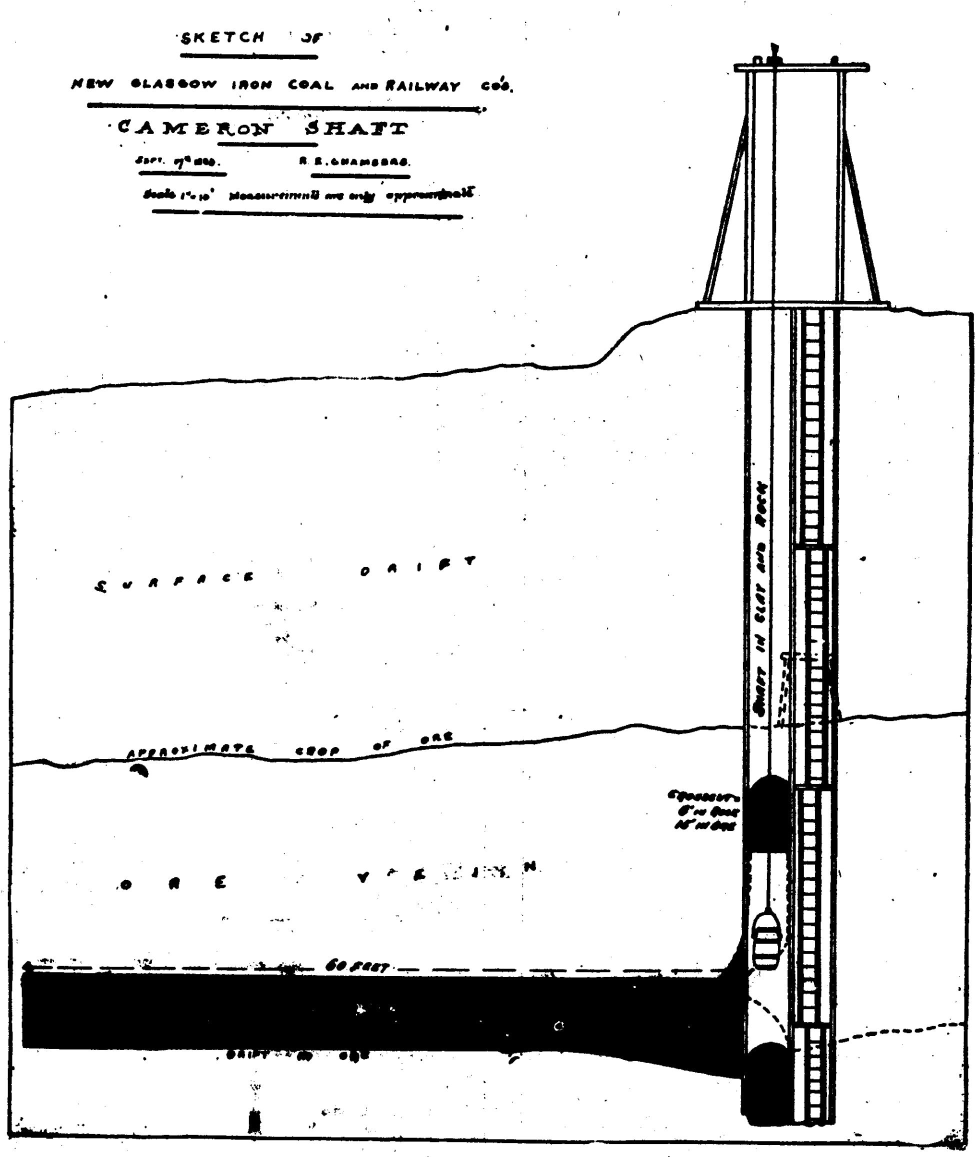
The prospecting plant includes a 20 h.p. locomotive portable boiler and hoist.

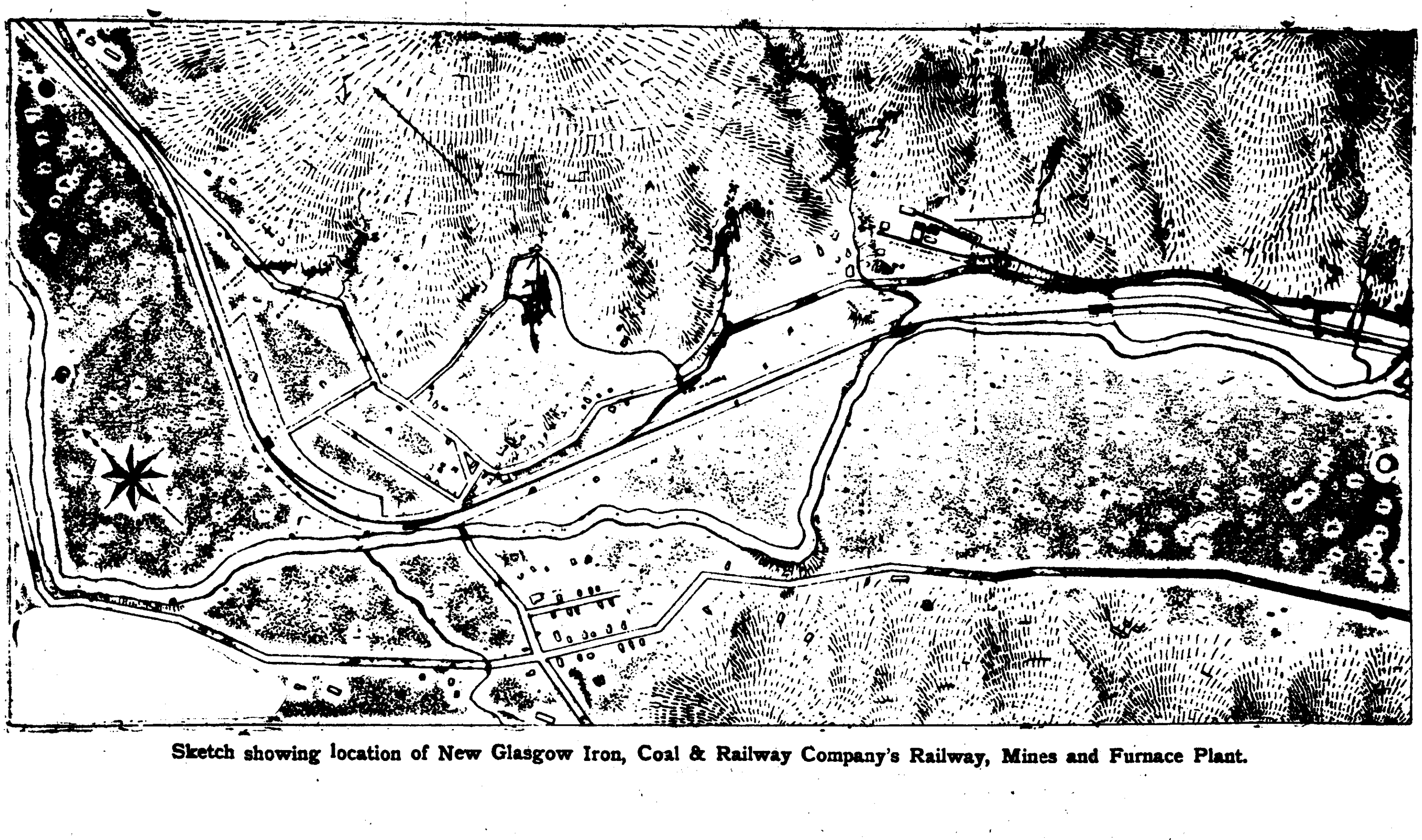
The Detonation of High Explosives by Percussion.

Mr. W. J. Orsman, in the *Transactions* of the Federated Institution of Mining Engineers, vol. iii., page 574-579, has made some experiments to determine the effect of percussion in various explosives, and the difference between detonation and the explosion produced by percussion. Explosives may be arranged in the following three classes, the first requiring a detonator with 15 grains of fulminate of mercury and the third needing 30 grains:

1. Nitro-glycerine compounds, comprising dynamite, gelignite, blasting gelatine, carbonite, etc.
2. Nitro-cotton, including cotton powder, tonite, etc.
3. Nitrate of ammonia powders, including roburite, ammonite, etc.

Percussion experiments with a falling weight of 59 lbs. pointed at the lower end, exploded substances of the first class with a fall of 6 to 12 inches, of the second class with 2 to 3 feet, but with falls up to 40 feet the latter class explosives were not exploded but only decomposed locally. The explosion of roburite by a detonator did not ignite gunpowder.



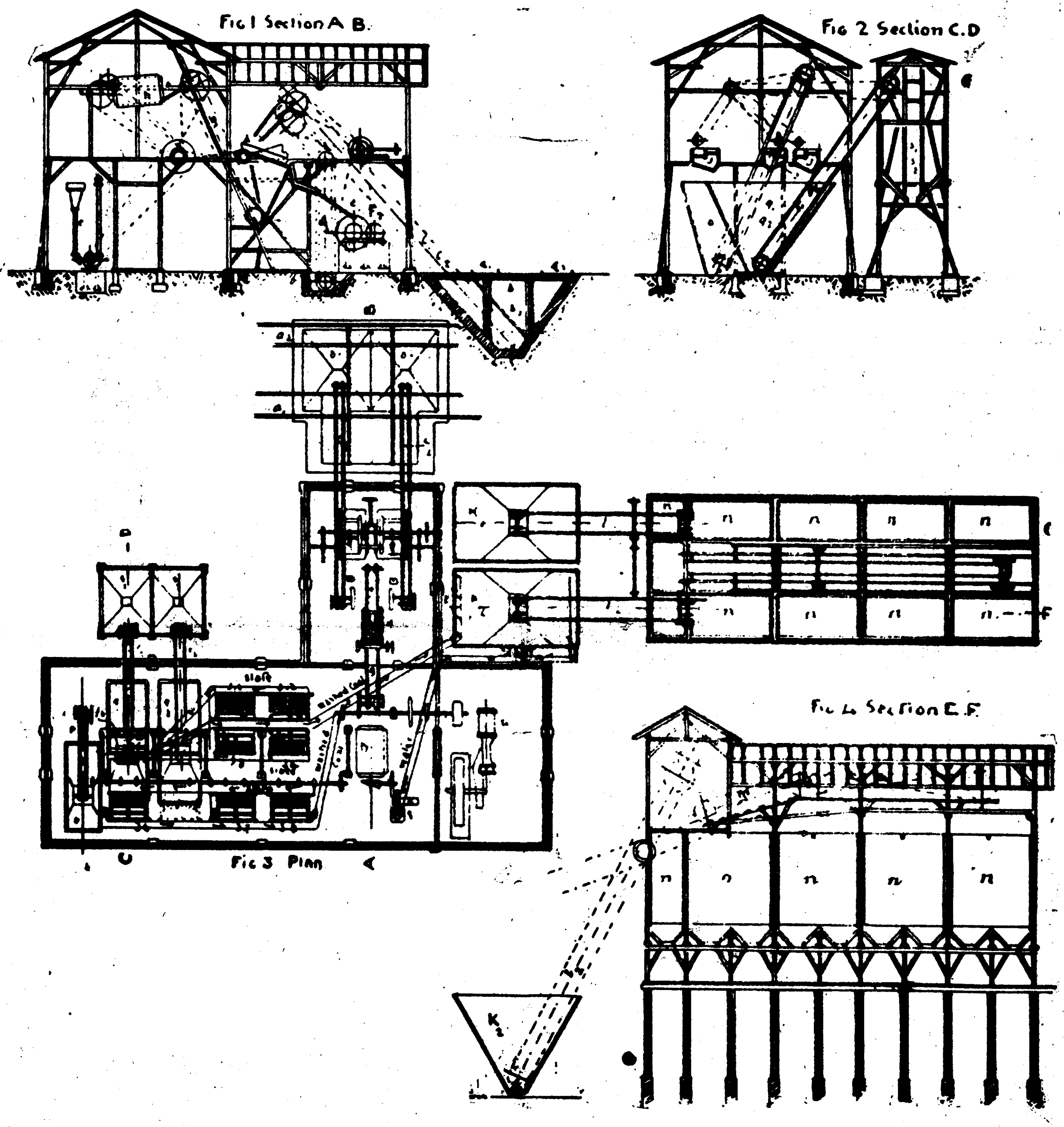


Sketch showing location of New Glasgow Iron, Coal & Railway Company's Railway, Mines and Furnace Plant.

New Glasgow Iron, Coal and Railway Company, Ltd.

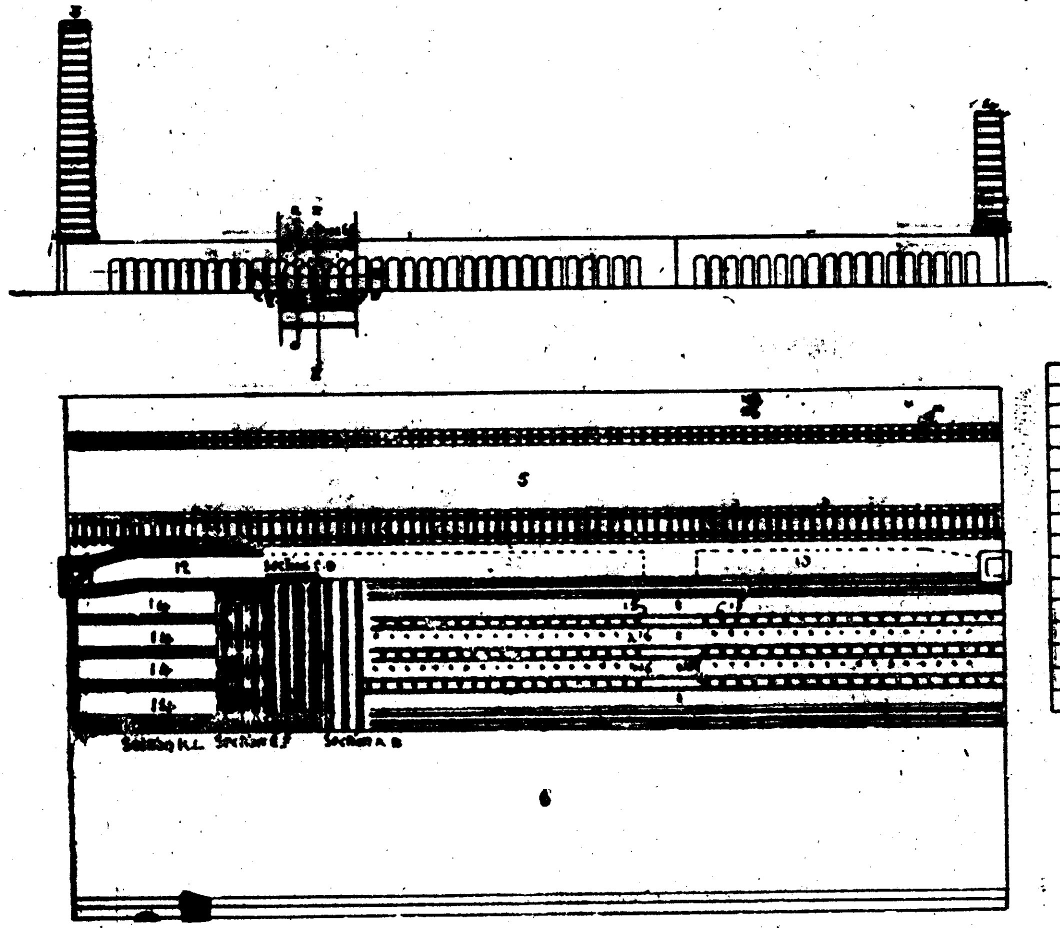
General Plan & Description of Coal Washing Plant of the New Glasgow Iron, Coal & Railway Co. Ltd.

Ferrona, N. S. Canada.

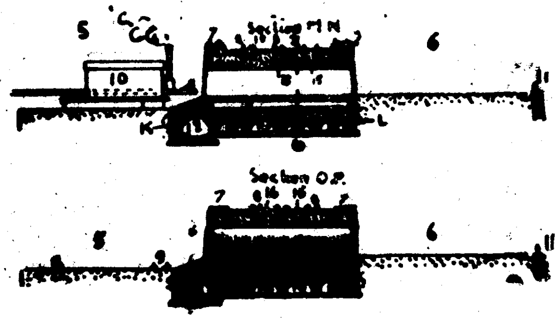


A_1-A_2—Railroad Tracks for arrival of coal from different mines.
B_1-B_2—Double Dumping Pit, so arranged that each kind of coal may be dumped separately.
C_1-C_2—Bucket Elevator to take coal from B_1 and B_2 to Shaking Table (Screen D).
D—Shaking Table Screen, with double eccentric motion, imitating hand screening as much as possible. The mesh of perforated screen plate is 3/8 inches.
E_1-E_2—Crushing Rolls, to crush the coal too large to go through the Shaking Table (Screen D).
F—Bucket Elevator. to elevate the crushed coal again to Shaking Table (Screen D).
G—Bucket Elevator, to take the coal which passes through the Shaking Table (Screen D) to
H—Separating Drum, which separates the coal into three sizes, o to 1/8 in., 1/8 in. to 1/4 in., 1/4 in. to 3/8 in.
J_1-J_8—Two-Compartment Fine Corn Coal Jigs. The coal chutes from the Separating Drum H to these Jigs. The washed coal from the Jigs flows into
K_2—Elevator Boot, and is taken from there to top of Storage Tower by means of
L_2—Perforated Bucket Elevator, which discharges the coal on
M—Conveyor Band, which distributes the coal into
N—Compartments of the Coal Storage Tower.
The Jigs shown in dotted lines and
K_1—Elevator Boot,
L_1—Perforated Bucket Elevators, are contemplated to be put in if a larger capacity is required.
The Slate from Jigs J_1 to J_8 is discharged into
Q_1—Elevator Boot, and is taken by
R_1—Perforated Bucket Elevator into
S_1—Slate Storage Tower.
J_5—Jig can be arranged to re-wash the Slate if necessary. In case the slate is to be re-washed it is discharged into
O—Elevator Boot in place of Q_1, and is taken to Jig J_5 by means of
P—Perforated Bucket Elevator. The Jig J_5 discharges the final Slate into the Elevator Boot Q_1, from whence it is conveyed b means of Perforated Bucket Elevator R, to Slate Storage Tower S_1.
The coal obtained from the re-washed product can either go with the washed coal to Elevator Boot K_2, or be discharged into
Q_2—Elevator Boot, and be taken by
R_2—Perforated Bucket Elevator t
S_2—Storage Tower, if the percentage of ash is too high for coking purposes.
T—Centrifugal Pump, to which all the water returns from the Elevator Boots, and is used over again.
U—Steam Engine.
If the Slate is not to be re-washed the Jig J_5 can be used for washing coal.

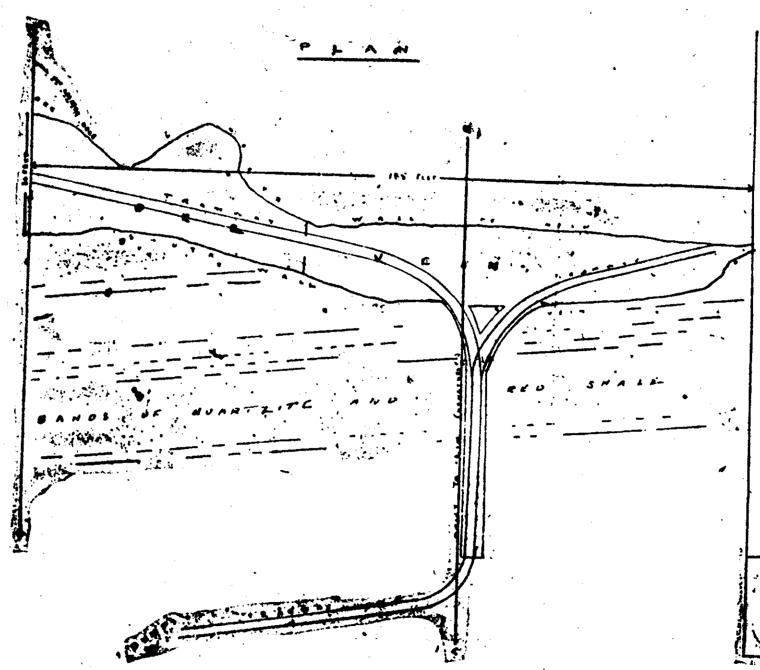
New Glasgow Iron, Coal & Railway Company, Ltd.

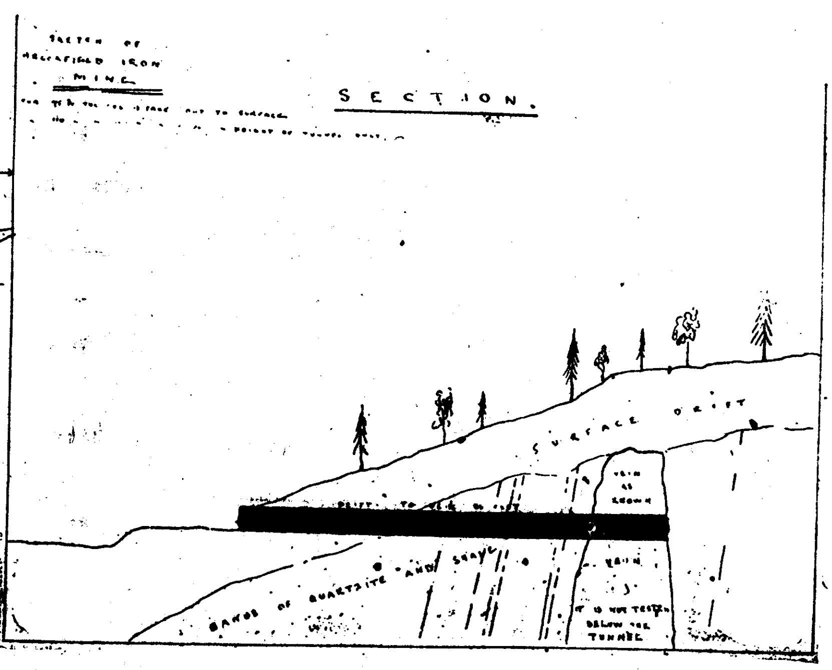


1	Battery of 36 Retort Coke Ovens
2	" " 18 " " "
3	Chimney for #1
4	" " #2
5	Side of Coke Pushing Machine
6	Coke Discharge Side
7	Tracks for windlass for raising Doors of Ovens
8	" " Lorries " charging Coal
9	" " Coke pushing Machine
10	Coke Pushing Machine
11	Water Supply
12	Main Gas Flue of #1
13	" " " " #2
14	Air Flues
15	Charging Holes
16	Air



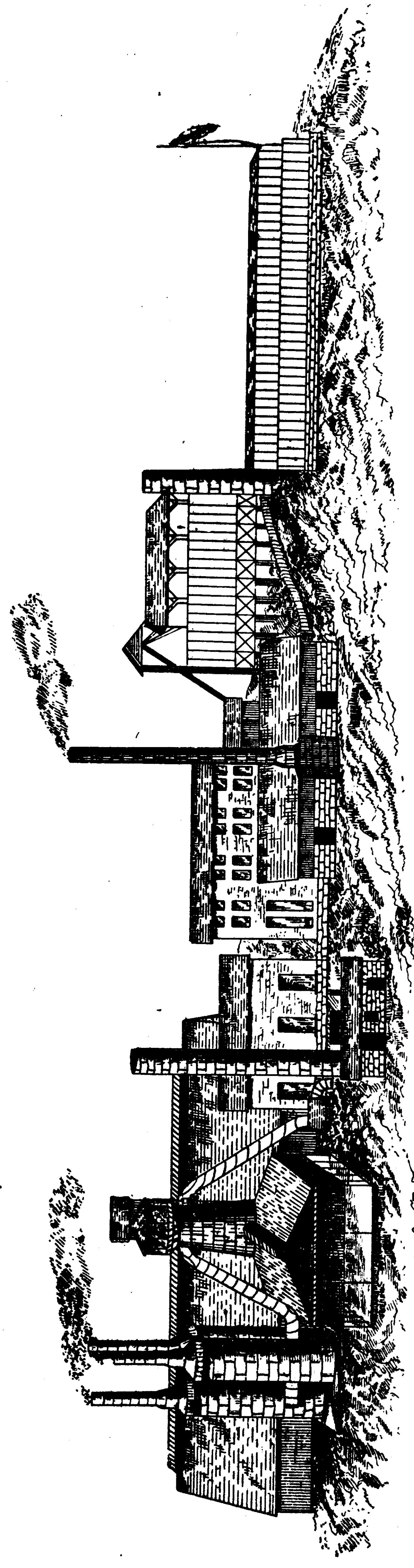
Double Battery of 54 Retort coke Ovens.
Bernard's System.
of the New Glasgow Iron, Coal & Railway Co L^td
Ferrona, N.S., Canada.





New Glasgow Iron, Coal & Railway Company, Ltd.

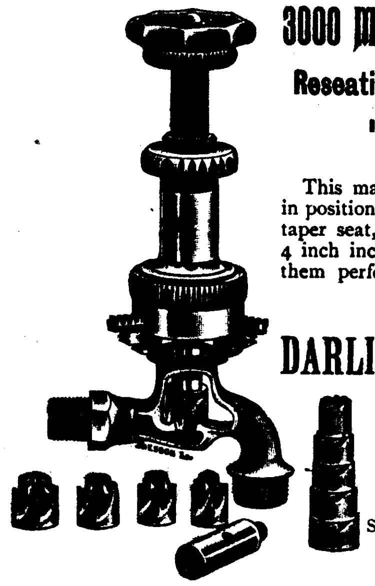
Exterior View of Furnace Plant at Ferrona, N. S.



1. Blast Furnace.
2. Blast Tower.
3. Hot-Blast Stoves.
4. Slack House.
5. Cast House.
6. Engine House.
7. Stand-Pipe.
8. Blacksmith's Shop.
9. Boiler Chimney.
10. Coal Washing Building.
11. Coal Storage Tower.
12. Boiler House.
13. Retort Coke Ovens.
14. Pig Iron Track.
15. Cinder Track.
16. Slack House Track.

New Fire-Damp Indicators.

A new form of alcohol lamp for the determination of fire-damp has been devised by G. Chesneau, in the (Annales des Mines, 9th series, vol. 11, pp. 203-223), with the object of overcoming some of the difficulties incident to the use of the Pieler lamp. Experiments were first made with lamps of the Marsaut and Wolff types, and these led to the adoption of a modification of the Fumat lamp. The air-supply enters at the base through a double gauze, which can be closed by a sheld. A sheet-metal cylinder surrounds the wick tube and serves as a shade. The gauze is somewhat conical, and is surrounded by a shield pierced by a window for observation. It is found that the height of the cap and the flame depends considerably on the nature of the spirit used, so that alcohol of the same density should always be employed. The use of metallic salts to render the flames more distinct was experimented with, and it was found that the addition of cupric chloride was advantageous, giving a uniform green tint. This salt is soluble in alcohol, and is used to the extent of thirty drops of a concentrated solution in strong hydrochloric acid perlitre. The height of the wick is adjusted by a regulating screw, and to insure, as far as possible, the same temperature, the lamp is allowed to burn about a quarter of an hour with the wick high. The tests should be made as quickly as possible, or else the lamp gets hot from the combustion of the gas, and the flame suffers an excess elongation. The author has found that variations of the carbonic anhyride and temperature of the air do not much affect the height of the cone when gas is present up to 2½ per cent., although the luminosity is affected. Results of a number of experiments are given, with tabulated results of the height of the cone and of the luminosity for varying percentages of gas.



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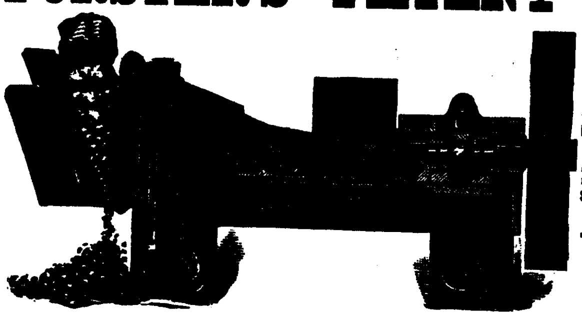

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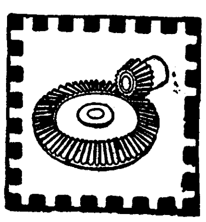

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SOME REMARKABLE RESULTS IN GOLD EXTRACTING.

New York *Sun*, Sept. 12.—"The Crawford Gold extractor, which was recently put into the Richmond Hill at Hillsborough, New Mexico, is giving satisfaction. It has been tested on runs of ores from different mines in the district with uniform good results."

Salt Lake *Times*, Aug. 28.—"Mr. Woodman came in from Deep Creek yesterday, where he has been for a month or six weeks, and he pronounces the Crawford mill a perfect success, saying that since the mill started it has saved 92 per cent. of the assay value of the Gold Hill ores, some of which are very rebellious."

John C. Smith, Supt. of the Ogema Mining and Smelting Co., says: "It gives me great pleasure to add my testimony in favor of the Crawford mill in every way, as to its 'gold saving qualities,' 'practically no loss of mercury,' 'small volume of water required per ton of ore,' great ease of manipulation,' also as to its portability to mines remote from railroads, and 'ease of setting up ready for operation.'"

L. J. Boyd, M.E., Supt. Montagu Mines, after personally supervising a test on arsenical ore says: "The results were simply wonderful. I am personally perfectly satisfied with this system of ore treatment, and should advise its adoption, as the experiments were carried on by my personal superintendence. Similar ore was treated by the Montagu stamp mill showing a difference of 100 per cent. in favor of the Crawford mill."

Fredericksburg, Va., *Free Lance*, Sept. 6.—"L. G. Johnston, of this city, in an interview, said he sent to the M.G.E. Co., N.Y., one ton of very low grade sulphuret ore from the mines of the Powhattan L. &. Mining Co., Culpepper Co. He went to New York and personally witnessed the working of the ore. The results of ten different samples of ore, averaging in assay value from $2.13 to $7.35 per ton, showed a saving of 88 per cent. of the value by actual mill run, this without the use of chemicals or fire. These results were so satisfactory that a large sized mill will be placed on the property at once."

W. D. Sutherland, Secretary of the Salisbury Gold Mining Co., of Nova Scotia, after having over 4 tons of ore treated by the Crawford mill, says: "Sample of the tailings taken during the run showed by assay an equivalent to 0.033 oz. to the ton. This evidence of the capability of the Crawford mill to extract all but a trace of the gold which the ore may contain must be considered of importance by all who are interested in the question of improved methods of milling gold from the ore. The test alluded to was made under the supervision of our company through trustworthy agents."

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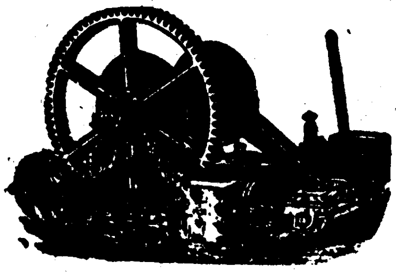

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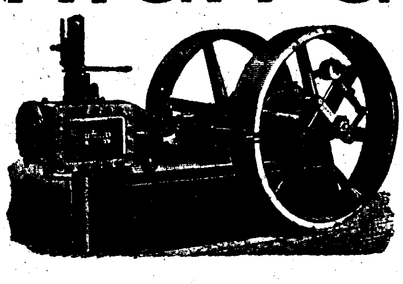

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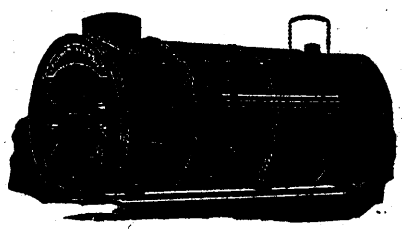

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