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TWENTIETH YEAR OF PUBLICATION

CANADIAN MINING REVIEW

Established 1882

Vol. XXI—No. XI. OTTAWA, NOVEMBER 30th, 1902. Vol. XXI—No. XI.

THE CANADIAN RAND DRILL Co

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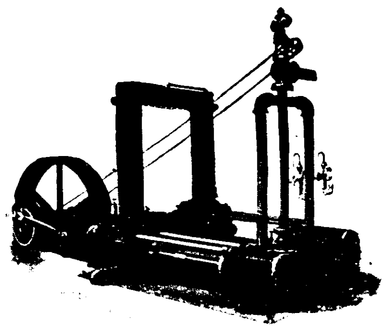

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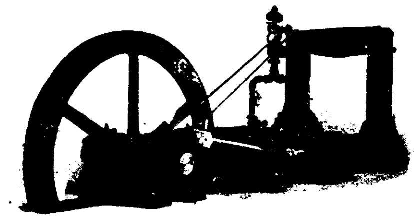

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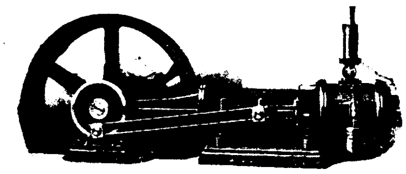

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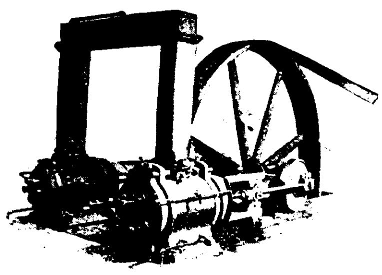

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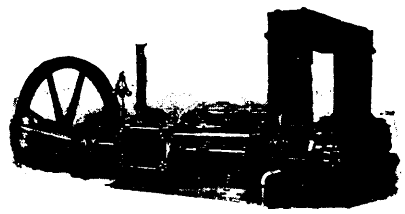

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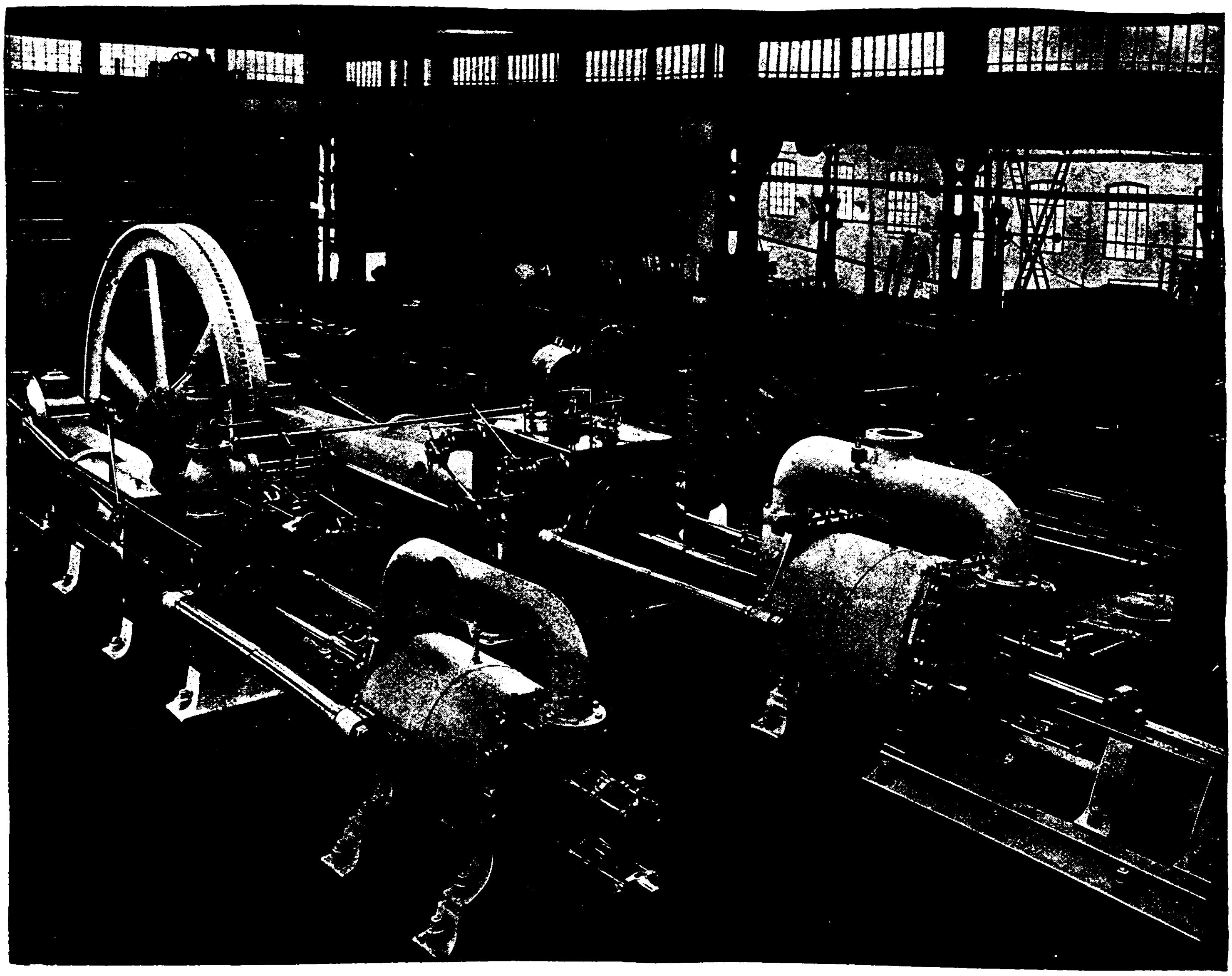

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DEAR SIRS,—We are pleased to confirm what we told you verbally the other day, viz : that we consider the Air Cylinders and Valves of your Compressors to be the best for such work as we have been carrying out on the above Contract.

One of your Engines ran for almost a year without stopping, and it gives us great pleasure to thus testify to the good qualities of the plant which we purchased from you.

We are, Dear Sirs, Yours faithfully. (Signed) pro S. PEARSON & SON, E. W. MOIR.

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The CANADIAN MINING REVIEW

Established 1882

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B. T. A BELL, Editor and Proprietor.
Secretary, Canadian Mining Institute, etc.

Published Monthly.

OFFICES { Orme's Building, Ottawa; Windsor Hotel, Montreal.

VOL. XXI., No. 11. NOVEMBER, 1902. VOL. XXI., No. 11.

Our Cement Industries.

The enormous growth in the production of cement during the past few years is due, in part at least, to the extensions of its use into departments of construction into which other materials have hitherto been used. A summary of the statistics of the production and prices in Ontario, the largest producer, during the ten years from 1892 to 1901 will show that while the production has been increased six and a half times, the prices have ruled very steadily.

YEAR.	Natural Cement.			Portland Cement.		
	Bbls.	Value.	Per Bbl.	Bbls.	Value.	Per Bbl.
1892	54,155	$38,580	$0.71	20,247	$47,417	$2 34
1893	74,353	63,567	0.86	31,924	63,848	2.00
1894	55,323	48,774	0.88	30,580	61,060	1.82
1895	55,219	45,145	0.82	58,699	114,332	1.95
1896	60,705	44,100	0.73	77,760	138,230	1.78
1897	84,670	76,123	0.90	96,825	170,302	1.76
1898	91,528	74,222	0.81	153,348	302,096	1.97
1899	139,487	117,039	0.84	222,550	444,227	2.00
1900	125,428	99,994	0.79	306,726	598,021	1.95
1901	138,628	107,625	0.78	350,660	563,255	1.61

Since 1899 there has been no increase in the manufacture of natural cement, while the output of Portland cement has gone up about fifty per cent. In 1899 the prices ruling for both varieties of cement were practically the same as in 1893. Natural cement is just now quoted at $1.55 to $1.60, while Portland, according to quality, brings from $1.90 to $2.75. The increase in production has been mostly in Portland cement, the output of which in 1901 was more than seventeen times the quantity manufactured in 1892. But in spite of this great advance the importation of cement from Great Britain, the United States, Belgium, Germany and other countries has continued to increase, so that for the seven months ending January 31st, 1902, Canada imported cement to the value of $610,041, the United States furnishing five-sixths of the total.* The low prices ruling in Canada in 1901 may be explained by overproduction in the United States and the consequent necessity of finding a market for the overplus.

But the markets will stand a steady and large increase in the world's output. There is a growing demand for Portland cement not only for foundations, but for the walls of buildings. Reinforced by steel rods it is being extensively used for construction in many cases where great strength and solidity are required. In Europe piles are being made of steel and cement, and are found to stand driving better than wood.

While the cement industry is growing in Canada as fast perhaps as is healthy, the selection of sites and material for cement works would be greatly facilitated by a better knowledge of our clay, marl, and limestone deposits. Here is a large piece of work to which we call the attention of our national and provincial departments of mines. It has a direct bearing on an industry which is already producing nearly three quarters of a million dollars' worth a year, and which is capable of great expansion. The returns from such a piece of work are not problematical and they are not in the far distant future.

*Report of the Ontario Bureau of Mines, 1902, p. 53.

Canadian Trade in Mining Machinery.

The value of the mining and metallurgical industries of Canada and their rapidly increasing importance to the trade and commerce of the Dominion are very clearly demonstrated in the remarkable expansion which has taken place during the last few years in our trade, both domestic and foreign, in mining machinery and mine supplies.

The steadily increasing value of our production of minerals and metals, now approximating at the pit's mouth close upon $80,000,000 annually, the continued opening up and development of new mineral territory, the large expenditures on the installation of modern plants for our mines, mills, furnaces and smelters, have developed not only a very well organized and flourishing industry in the manufacture of special lines of mining equipment within the Dominion but also a large and growing trade with other countries. During the past two fiscal years official returns show that our enterprising neighbours in the United States supplied us with mining machinery of the value of two and a half millions of dollars. It is also gratifying to note that our imports from the mother country, while still not very large, are steadily improving.

The Canadian Customs tariff, while giving, very properly we think, a reasonable measure of protection by imposing a moderate duty upon those lines of mining machinery which are made at home, provides a very liberal Free List under which the bulk of the machinery noted below has been brought in. This List, we understand, will be still further extended during the next revision of our Customs tariff. The following figures have been carefully compiled by the Review from the Trade and Navigation blue book annually published by the Department of Customs:—

Free machinery imported in	1898 of a value of	$128,780
" "	1899 "	207,737
" "	1900 "	724,187
" "	1901 "	1,535,225
" "	1902 "	904,267

These figures are for the fiscal year ending 30th June.

The following figures show the value of the free and dutiable mining machinery imported during the past two years and the sources from which it was derived:—

—	1901	1902
Imported free of Duty—		
From Great Britain	$31,181	$14 061
" France	2,136	......
" Austria	......	50
" Germany	3,244	10,163
" United States	1,496,664	793,881
Total free machinery	$1,535,225	$848,155
Imported subject to 25 per cent. duty—		
From Great Britain	25,913	7,531
" Germany	......	81
" United States	56,600	48 500
Total imports of mining and smelting machinery	$2,617,738	$904,267

The figures in detail for the nine months from 1st January to 30th September last and the entries during the same period of the previous year show:—

Month	1901			1902		
	Free	Dutiable	Total	Free	Dutiable	Total
January	$111,134	$4,196	$115,330	$92,984	$2,549	$95 533
February	162,030	9,689	171,719	43,123	2,380	45,503
March	62,185	806	62,991	55,255	2,629	57,884
April	52,921	517	53,438	61,227	5,087	66 314
May	259,309	6,180	265,489	90,820	4,782	95,602
June	162,674	12,269	174,943	77,270	5,293	82,563
July	58,919	4,267	63,186	47,511	2,171	49,682
August	70,979	16,428	87,407	90,798	1,139	91,937
September	84,479	599	85,078	82,090	8,906	90,996
Total	$1,024,630	$54,951	$1,079,581	$641,078	$34,936	$676 014

The following table shows in detail the sources from which Canadian mining and smelting machinery were derived during the last nine months of the year:—

Month	United States		Great Britain		Other Countries	Total
	Free	Dutiable	Free	Dutiable		
January	$66,236	$2,549	$26,328	...	$420	$95,533
February	42,486	2,380	637	...	...	45,503
March	54,980	1,720	275	$909	...	57,884
April	55,618	4,997	5,579	90	...	66,314
May	90 623	4,782	197	...	...	95,602
June	76,409	5,293	811	...	50	82,563
July	47,444	2 171	...	...	67	49,682
August	81,627	1,139	9,162	...	9	91,937
September	81,608	8,535	180	371	302	90,996
For 9 mos.	$597,061	$33,566	$43,169	$1,370	$848	$676,014

While these figures show a falling off in the value of our imports compared with the same period in 1901, it is well to remember that last year was especially notable for opening up and equipment of many new furnaces and smelters, and that in the earlier months of the present year mining activity in British Columbia was greatly restricted by labor troubles and a severe depression in the market for our silver-lead ores. This trade is, however, only in its infancy, and the continued expansion of mining activity throughout the Dominion will materially increase the value of our trade in mining machinery in the future.

Pig Iron Production.

The American Iron and Steel Association has received direct from the manufacturers the statistics of the production of pig iron in Canada in the first six months of 1902. The figures show a slight increase as compared with the last half of 1901, but a very great increase as compared with the first half of that year.

In the first six months of 1902 the production of all kinds of pig iron in the whole of the Dominion amounted to 157,894 gross tons, as compared with 149,952 tons in the last half of 1901, 95,024 tons in the first half of that year. The increase in the first half of 1902 over the last half of 1901 was 7,852 tons, or over 5 per cent, while the increase over the first half of 1901 was 62,780 tons, or over 66 per cent. Of the total production of the first half of 1901, 12,000 tons were Bessemer and basic pig iron. The coke furnaces made 147,392 tons and the charcoal furnaces 9,912 tons. Neither spiegeleison nor ferromanganese has been made in Canada for several years.

The unsold iron held by the Canada pig iron manufacturers on June 30, 1902, none of which was intended for their own gross consumption, amounted to 37,721 gross tons, as compared with 59,472 tons on December 31, 1901. Of the unsold iron on hand June 30, 1902, less than 2,000 tons were made with charcoal, the remainder being coke iron.

On June 30, 1902, Canada had 14 completed blast furnaces, of which eight were in blast and six were idle. Of this total nine were equipped to use coal for fuel, four to use charcoal and one to use mixed charcoal and coke. In addition three coke and two charcoal furnaces were being built on June 30, 1902 but work upon two of the coke furnaces was temporarily suspended.

The Ophir Fight.

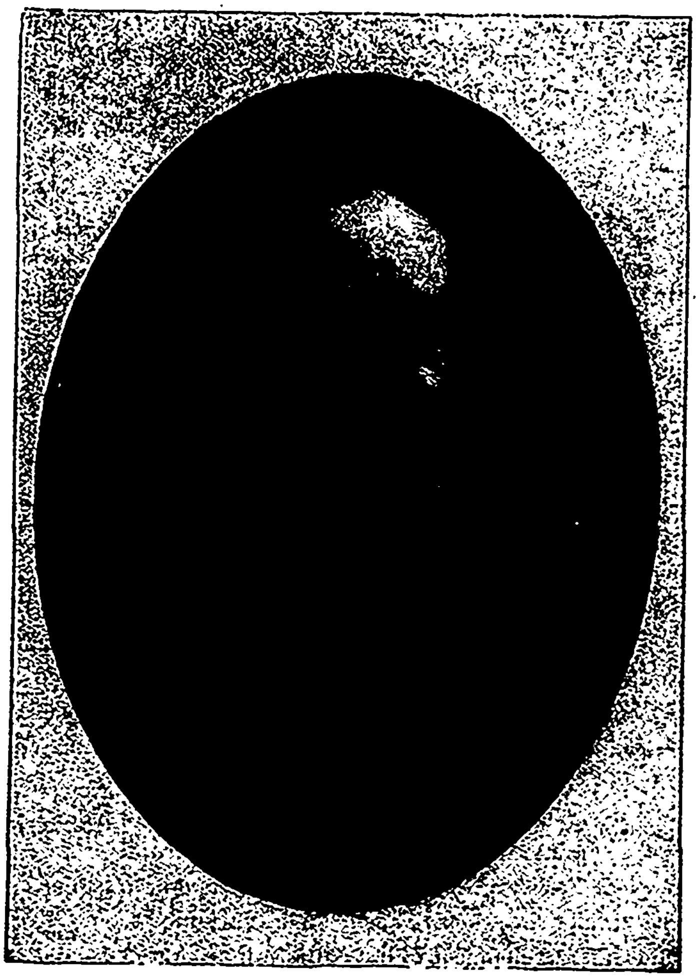
The Judicial Committee of the Privy Council have rendered a final decision in this long pending litigation in favor of the Ontario patentees, Messrs. E. Seybold *et al.*, who were represented in the Crown Land Department and in the Courts by Mr. J. M. Clark, K.C. The origin of the contest dates back to the "Boundary Dispute" between the Province of Ontario on the one hand and the Dominion of Canada and the Province of Manitoba on the other. This dispute was decided in favor of Ontario in 1878 by arbitrators but their award was repudiated by the Dominion. The matter was then referred to the Judicial Committee of the Privy Council, their decision in favor of Ontario being confirmed by Imperial legislation. The Dominion then claimed the land by virtue of the so-called Indian title. This claim was fought in the Courts and was decided both in the Canadian Courts and by the Privy Council in favor of Ontario. The last point in the series of questions arose in the present case in regard to a tract of land including Sultana Island which the Dominion authorities purported to set apart as an Indian reserve although the lands belonged to Ontario. This question is now finally decided. The statement of the law in regard to the question contained in McPherson & Clark's Law of Mines in Canada was approved in Canada and has now been confirmed by the Privy Council, the final authority in such matters.

The Late Dr. Selwyn.

—

We are deeply grieved to record this month the death of our old friend, Dr. A. R. C. Selwyn, for many years Director of the Geological and Natural History Survey of Canada. Dr. Selwyn, who was in his seventy-eighth year, had been living since his retirement from the Survey at Vancouver, B.C., and he died there on the 24th ultimo. He had been in failing health for some time and the sad event was not unanticipated.

Alfred Richard Cecil Selwyn, C.M.G., LL.D., F.R.S., was born in Somersetshire, England, in 1824. He was the youngest son of the Reverend Townshend Selwyn, Canon of Gloucester Cathedral. His mother was the daughter of Lord George Murray, Bishop of St. David's, and grand-daughter of John, fourth Duke of Athol. His early education was received from a tutor at home, but later he was sent to Switzerland, where he completed his studies. After leaving school, some years were spent partly in travel in Belgium, France, Switzerland and the Tyrol, and partly in the position of a clerk in mercantile houses in London and Liverpool. This latter occupation, however, was distasteful, and having already acquired considerable knowledge of geology as an amateur, Mr. Selwyn gladly availed himself of an appointment as Assistant Geologist on the Geological Survey of Great Britain. The ability he displayed in this position soon attracted the notice of distinguished geologists, and in 1852, on the recommendation of Sir H. T. De la Beche, the Director of the Survey, Mr. Selwyn was appointed by the Secretary of State for the Colonies, to undertake the geological survey of the colony of Victoria, Australia. About this time much interest had been aroused respecting the gold fields and coal beds in Tasmania, and the Government of that colony decided to obtain the services of a practical geologist to decide the question. Mr. Selwyn was asked to undertake the work, and consenting, at once began a thorough and systematic examination of Tasmania, his report on which was highly satisfactory. In 1859 he undertook with equal success a similar service for the Government of South Australia. Previous to this, in 1856, he was appointed one of the commissioners of mines for Victoria; in 1858 he was made a member of the Science and Prospecting Board, and in 1861 appointed a commissioner for the Victoria International Exhibition. The esteem in which Dr. Selwyn was held by the Government and people of the colony is best shown by these and other distinctions accorded him.



THE LATE DR. A. R. C. SELWYN, C.M.G.
Director of the Geological Survey of Canada, 1869 to 1895.

He was a member of the Government Tender Board and of the councils of the Board of Agriculture, of the Royal Society, and of the Acclimitization Society. In 1869, Sir William Logan having resigned, the position of Director of the Geological Survey of Canada was offered to Dr. Selwyn, and he accepted. His work since then is well known; the lines laid down by his predecessor have been carried out to a large extent, but the field has so greatly enlarged that the present system may fairly be said to have originated with Dr. Selwyn. The responsibilities of such a position were very great, and his task had been rendered more arduous by the small sums appropriated by Parliament for the purposes of the Survey. A regretable dissension also at one time greatly added to the difficulties of his position; and this, together with certain ill-advised criticisms made either in malice or ignorance, which had appeared, caused the appointment of a Royal Commission in 1884 to enquire into the system and work of the Survey, the report of which silenced these complaints. Very mistaken ideas as to the objects and functions of the institution had been held. The Geological Survey is carried on in the interests of science more than of commerce. It never was intended that it should be a sort of National Prospecting Agency, for the purpose of discovering and appraising mineral deposits, and collecting commercial statistics, though this latter feature has been introduced and is carried out to a great extent, but rather that by it the geological structure of the country should be mapped out, thus indicating to the prospector the general areas in which he might reasonably expect to find the mineral he sought.

While administering the details of the Survey and Museum, Dr. Selwyn took an active part in the work of exploration. Amongst the most important of his expeditions were: In 1871 from Victoria, B.C., to the Rocky Mountains by the North Thompson and Fraser rivers; in 1872 a canoe voyage from Port Arthur to Winnipeg; in 1873 from Winnipeg across the plains to the Rocky Mountains, returning by the Saskatchewan River and Lake Winnipeg; 1875 from Victoria, B.C., to Peace River and return; in 1882 a boat voyage from Port Arthur around the whole northern shores of Lake Superior to Sault Ste. Marie. Besides these long and arduous explorations, Dr. Selwyn made many journeys and geological observations over large portions of every province of the Dominion, and as the foregoing record shows he was actively and continuously engaged in geological work for forty-seven years.

Dr Selwyn, as Director of Geological Surveys, on behalf of the

Government of Victoria, Australia, and later of the Dominion, took a prominent and active part in the collection and preparation of the mineral exhibits at six International Exhibitions: Melbourne-Dublin, 1854-55; Melbourne-London, 1861 2; Melbourne-Paris, 1878; London, 1886 From all these exhibitions he was awarded gold, silver and bronze medals and diplomas. At the Paris Exhibition in 1878 he was elected Chairman of the Jury on Cartography, and was awarded the Cross of the Legion of Honor, and in London in 1886 that of the Order of St. Michael and St. George.

Since 1869 he edited and contributed to sixteen volumes of reports with numerous maps and illustrations relating to the structural geology and to the mineral, vegetable and animal resources of the Dominion. He is also the author of the Canadian part of Stamford's "Compendium of Geology and Travel—North America," London, 1883. In 1881-2 he superintended the removal of the Geological Museum from Montreal, and its re-organization on a broader basis in Ottawa, where it now embraces natural history, as well as mineralogy and geology, and has become the most complete existing collection illustrating the natural resources of Canada.

Nor is it only on the other side of the Atlantic that Dr. Selwyn's abilities have met their just appreciation. Both in the United States and Canada his work is held in high esteem. A leading scientist in New York has said of the maps published by him that they are "truly magnificent; my highest expectations are more than realized in them; they are, indeed, models of method and precision, and the most noble monuments to their originator." Another gentleman in a high position in the Lower Provinces said: "It is my unbounded appreciation of what has hitherto been done by the corps of the Geological Survey, under the directorship of an able and eminent chief of whom Canada may well feel proud, which prompts me to suggest and impels me to advocate the expenditure of a few tenths of a cent more apiece, to enable the Survey to continue recording and establishing in the most satisfactory manner, work that is being well done, and which ensures the industrial development of the country, while it will be at the same time a source of honest national pride when we compare our record with that of other countries." Many other encomiums might be cited did space permit, but sufficient has been said to show that Dr. Selwyn's worth was widely known and honored in the scientific world.

Last year the mining men of the country, through the Canadian Mining Institute, presented to the Geological Survey an excellent memorial portrait of Dr. Selwyn, as an appreciation of his work and the great services he has rendered towards the development of the mineral wealth of the Dominion.

CANADIAN MINING INSTITUTE.

The following communications have been received by the Secretary *re* discussion of papers read before the Institute:—

Mine Timbering by the Square Set System at Rossland, B.C.

Mr. ERNEST WOAKES, Nelson—I have read with much interest Mr. Bernard MacDonald's paper on the square set system of timbering used at the Le Roi mine and I should like to hear from that gentleman how he would have adapted his system to the peculiar conditions which existed at the Darien Gold Mines in the Republic of Colombia, South America, a mine of which the writer had charge some years ago.

In Vol. XXIX of the Transactions of the American Institute of Mining Engineers the above mine is fully described. The ore body may be roughly described as having the form of an irregular quadrilateral measuring 90 feet wide from north to south, and 120 feet long from east to west, and standing nearly perpendicular. The country rock was a decomposed andesite having many cleavage planes so that it was very liable to break up and cave if left unsupported. The ore body was composed of boulders and rock fragments from the adjoining country rock varying in size from pieces as small as a walnut to masses of many tons weight. These fragments are generally completely angular partaking of a breccia-like formation but at times they were rounded and resembled a conglomerate. The rock fragments are completely surrounded and cemented together by concentric shells of crystalline sulphurets and calcite with a little quartz. The gold was mostly free and was found almost entirely in the cementing materials. The ore was very high grade.

Timber was fairly plentiful but as in most tropical countries the majority of it was of very poor quality. It commences to decompose almost as soon as cut and for all underground purposes cannot be relied upon for much over twelve months. The square set system was introduced and practical men from Nevada were engaged to teach the natives how to prepare and set up the sets. Round timbers were used for the posts and nothing under 18 inches diameter was put in. The caps were flattened by adzing on two sides and the ties were of sawn lumber 8 x 10 inches. Great care was taken in setting the sills in each level, they were set north and south, east and west, with the idea of making sure that the uppermost tiers in one stope would eventually correspond as nearly as possible with the sill sets of the stope above. It was also found useful at times in the mine to know the exact bearing by means of the timbers. Very soon after starting stoping it was found to be necessary to keep the sets close up to the stoping faces or falls would occur. The conditions were much aggravated in the upper levels by the presence of old workings. Finally, after the whole width of the ore body had been stoped and the sets carried up from four to six sets high, it was found that the ore body was commencing to settle and the whole weight was on the timbers. Falls and caves became more frequent and finally a cave started above the upper floor and kept breaking away upwards to such an extent that it could not be caught up and eventually the whole stope crushed in, the timbers being forced out of plumb as the weight on them increased. False sets and diagonal braces were put in to resist the pressure but this was of only temporary assistance. After the cave a tunnel was driven in the country rock round three sides of the ore deposit and crosscuts driven in from it and the ore extracted as it ran down, temporary sets being put in where necessary, in this way the ore was taken out until surface rock and tree stumps began to shew in the stopes. In the deeper levels it was decided to try a different system. The square sets were put in as before but were only carried three or four sets wide all round the ore deposit leaving a large square pillar in the centre which was taken out as far as was possible after the greater part of the ore body had been removed. Crosscuts were driven into the country rock from the various floors and the waste rock from these dumped into the stopes where the timber shewed the worst signs of squeezing. It was not deemed prudent to leave any ore in the stope as filling it being of such high grade that the loss would be very great. Besides, as is unfortunately so often the case, the mill was generally calling on the mine for ore. It was a very wet mine and the rainfall was excessive, viz.: 110 inches a year. For this reason it was not desirable to have large open workings at the surface liable to sudden flooding, as would have been the case if filling from the surface had been resorted to as is in the case with the Ymir mine in this country. I, of course, believe that in most cases where wide deposits have to be worked the square set system of timbering is the most satisfactory, if the mine can stand the cost of it, and after the mines have attained a certain depth it will often be found to be the only one possible. Luckily for mine managers conditions such as above described are not likely to exist very often, and if they do exist in the upper levels, it is to be expected that the ground will get harder and less liable to cave as depth is attained.

Mr. BERNARD MacDONALD, Rossland—I have read Mr. Woakes' criticism on my paper, "Mine Timbering by the Square Set System" and also that gentlemen's excellent article in Vol. XXIX of the Transactions of the American Institute of Mining Engineers, describing the Darien Mine, with great interest. I am sure any one who gives himself the pleasure of reading Mr. Woakes' description of this mining property will find corroborative evidence of the proposition that "no two mines are exactly alike."

In replying to Mr. Woakes' criticism I do so with the full knowledge of the difficulty of prescribing for a patient, without first seeing him and studying the idiosyncrasies of the malady. Therefore, the method of stoping and timbering the ore bodies in the Darien Mine, which I would propose as best suited for the peculiar conditions existing there would be considered as given under existing circumstances.

As a general rule when an underground ore body is being mined, greater strains are exerted on the timbers by the pressure on the enclosing walls than from the overhanging ore. On this account, the method of extracting the ore body generally adopted is by stopes or steps running horizontally within the vein and along it over the various levels and the spaces thus exhausted are timbered by "floors" or square sets extending horizontally between the enclosing walls. This is the method described in my paper.

But it seems that the generally prevailing conditions in mining operations were quite reversed at the Darien Mine, where the greater strains came from the overhanging ore, instead of, as is usual, from the enclosing walls. This might, in a measure, have been suspected from Mr. Woakes' description of the physical characteristics of the ore and the nearly vertical dips of the enclosing walls.

I would meet these reversed conditions by reversing the usual methods, or I should say direction of the stoping and timbering, viz.: I would run the stopes or steps of the excavation vertically upward between the mine levels, instead of horizontally over them.

For example: in stoping out any block of ore developed between two levels, I would first run a raise vertically through it, making such raise wide enough to be timbered into two compartments by two square sets going up in it side by side. When completed, this raise would furnish means of ventilation and access for men and material to whatever part of the ore body the work of stoping might be going on. I would then run all the stopes vertically upwards around this raise, commencing at the lower level and finishing at the upper level, mining out just enough ore at a time to admit of one new set of timbers being placed in the evcavation. By this method all the ore, except the one stope being excavated, would be supported on a solid foundation of ore in place. In case lateral or vertical pressure would give the timber sets a tendency to swing or "jack knife" out of their true horizontal and vertical position, as would probably be the case, I would keep the skeleton frame work of the sets filled up with broken ore, until all the block between levels was broken down. This method of temporary filling locks up for the time being about two thirds of the ore in the stopes. The swell in volume of the broken ore over that in place being only about one-third. However, the two-thirds used for temporary filling could be drawn off after the work of stoping was completed, so that except for the time being no more ore used in filling would be lost.

This method would, in my opinion, be best calculated to meet the conditions existing at the Darien Mine.

The Electrolytic Production of Metals with Special Reference to Copper and Nickel.

Mr. TITUS ULKE, Sault Ste. Marie—Permit me to thank you for your kindness in sending me copies of discussion relative to "The Electrolytic Production of Metals, with Special Reference to Copper and Nickel," which you published.

I have only recently returned here from a nine-weeks' trip, inspecting the copper mines and smelting works of British Columbia, Washington, California, Arizona, and Sonora, Mexico, and have therefore not had leisure to write you before.

As regards Mr. Koehler's reply to my last stricture, I need hardly call attention to the fact, *re* 1, that Dr. Schnabel's classification is logical, while Mr. Koehler's is not, his explanation to the contrary notwithstanding.

Re 3. Mr. Koehler is finally compelled to admit my stricture, viz., "that the chloride method has, to say the least, not yet attained commercially practical prominence," and that there are grave difficulties in its way not encountered in the ordinary sulphate method of electrolytic refining.

Re 7. As the technical press and leading experts view my process with unqualified favor, and as the novel features thereof are covered by broad patents, or pending applications for same, I need not further discuss the merits of my process.

The printed discussion, I take it, has fully borne out the merits of my contention and friendly criticism of Mr. Koehler's interesting paper, which I could not well pass over without noting the few inaccuracies cited.

Safety Lamps and Colliery Explosions.

Mr. JAMES ASHWORTH, Chaddesden, England—In reply to the discussion on this paper in your journal of the 30th of September, I agree with most of the conclusions arrived at by Mr. Blakemore, of Montreal, and Mr. Hardie, of Lethbridge.

It is quite possible that the explosion at Fernie was initiated by the failure of a Clanny lamp, but it is *impossible* for an explosion within any safety lamp to "shatter" the lamp, and it is also impossible to even open the seam of a gauze by an explosion within the lamp if it has been made with any ordinary care. A lamp might fail and then be broken by a fall of roof, but even this is not of one of the likeliest of possibilities, because the point where an explosition originates is the one from which the destructive forces radiate, and is therefore the centre of compression, and no force passes over the lamp—it may in fact be said to be immersed in the force. Sometimes there is evidence of the "back lash" of the explosion when the vacuum resulting from condensation comes into play, and under this condition a lamp in a main road might be knocked about, but it would show that the force which smashed it was operating from the outside and not from the inside.

There cannot be a doubt in the minds of people who have seen fine coal dust ignite inside a safety lamp, that it will do so more readily than firedamp, and also that as the particles are so small as to pass through the mesh of the gauze, flame from the ignited or incandescent coal dust may be produced outside the gauze and be the cause of a disaster even without an explosion within the lamp.

Both Mr. Blakemore and Mr. Hardie recognise this risk as a valid and dangerous one, and about which we require more information.

Mr. Blakemore considers the use of benzolene in safety lamps as a fatal drawback, but in this respect I must differ with him entirely. Benzolene or, as it is sometimes called in England, colzalene (also benzine in translations from the German) has been and is still very extensively used as an illuminant, and judging from a long experience with it, I can say that it may be applied with perfect safety in a safety lamp, if the lamp is properly constructed to burn a volatile oil or spirit. Lamps thus supplied are not quite so economical in the cost of lighting as when using paraffin, or oil mixtures, but it is cleaner, and gives a good illumination with the minimum of attention. The greatest danger arising from its use is in the filling of the lamps, and they ought not to be filled to a greater degree than the sponge or cotton wool will absorb. Then the lamp itself should be of the best construction, and in my paper I called attention to two distinct risks which are attached to the Wolf class of lamp, viz.: 1st, the double air admission, that is from below the flame as well as from above the flame,—this construction was proved by the English Mines Accidents Commission of 1886 to be a far from safe mode of feeding the flame with air, and confirmed the experiments previously made by M. Marsaut; 2ndly, the igniting apparatus, which if brought into use whilst the lamp is full of gas mixture will originate an explosion and propel the flame straight through the gauzes. Therefore, I say that benzolene may be a perfectly safe and an excellent illuminant, if applied under a safe cover.

For gas testing purposes, and if applied in lamps of the Gray type, it is one of the best and handiest means of testing for lower percentages than can possibly be detected by an oil flame. I enclose

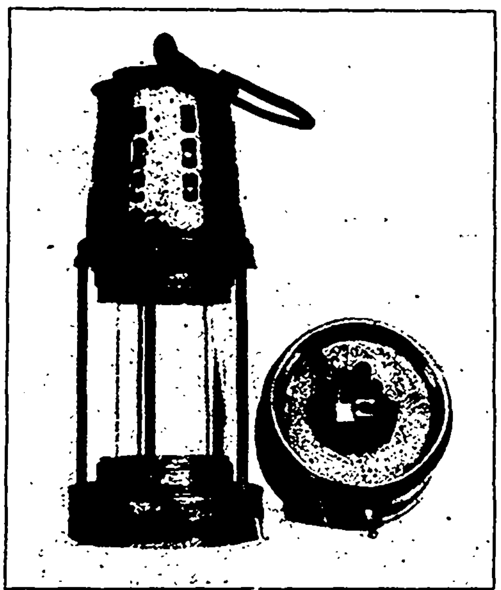


FIG. I.—Ashworth's patent tri-wick safety lamp, for burning petroleum spirit, and fitted with the Wolf patent relighter.—Illumination equal to 1½ standard sperm candles.

you a photo of one of my Gray oil vessels constructed to use benzolene and fitted with a Wolf igniter, for the use of firemen and examiners, Fig. 1.

Mr. Hardie's remarks are also an extremely interesting chemical review of the dangers arising from mixtures of coal dust and firedamp, and are worthy of the closest attention. He says that he most carefully examined the East mine of the South West Virginia Improvement Co. to find traces of firedamp, but he does not say what lamp he used. This point is of the first importance because he goes on to prove that the lamps in use, and as used by men in general, will not indicate much less, if any, than three per cent. His report after examining the same mine with the Ashworth-Gray type, using alcohol as the testing flame, or with the hydrogen gas test introduced by Dr. Clowes and myself, Fig. 2, would be very valuable for comparison.

With regard to the percentages of firedamp which safety lamps will detect, I may say that I purpose testing ordinary safety lamps in measured mixtures of gas and air, and in course of a few weeks I may be in a position to reply more directly to Mr. Hardie's enquiry as to

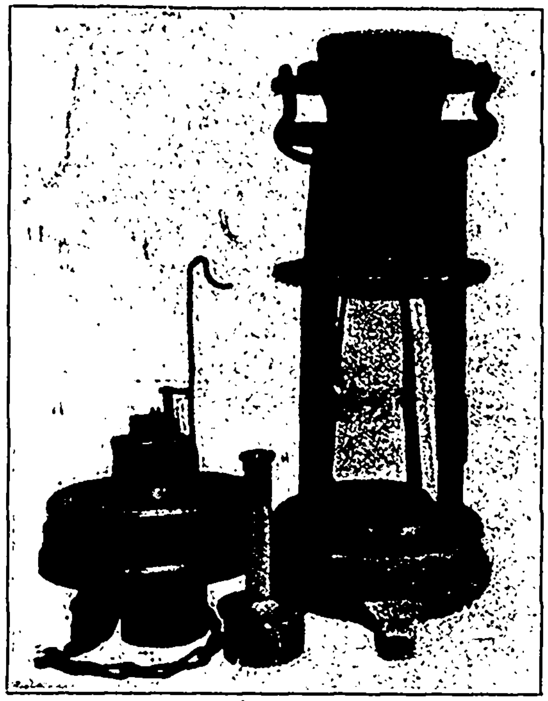


FIG. II.—Ashworth-Gray safety lamp with Ashworth, Clowes & Co.'s hydrogen gas-testing attachment.

the percentages represented by certain caps, but in the meantime I may make the following general statement:—

If ⅛ in. of "cap" is seen on a testing flame which is ⅛ in. high, and the total height of flame from the top of the wick tube is a full ¼ in., it would probably indicate 2½ per cent. of firedamp. In like manner a ¼ in. "cap" would, if of a total height of ⅜ in. above the top of the wick tube, indicate the presence of 3½ to 4 per cent. of firedamp, and a ½ in. "cap," with a total height above the top of the wick tube of ⅝ in. would indicate about 5 per cent. of firedamp.

To give a list of "cap" heights with corresponding percentages of firedamp applicable to all types of safety lamps is impossible, as the height of the "cap" is entirely ruled by the heat of the testing flame, its non-luminosity, and the surroundings of the flame. The truth of this will be rendered clear by a comparison of the "caps" produced

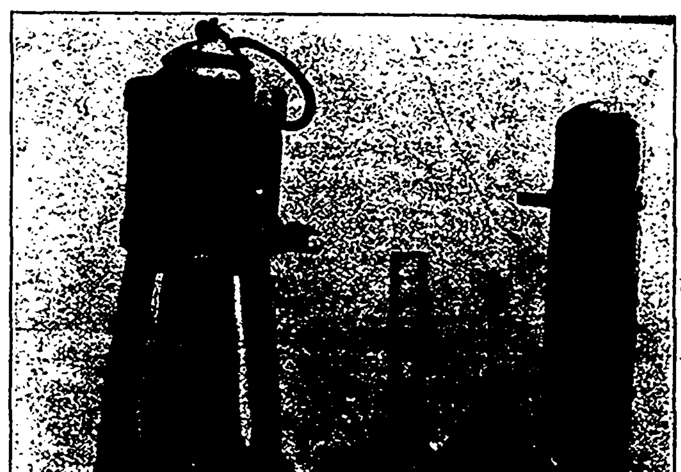


FIG. III.—Ashworth-Gray, with Stokes' alcohol spirit gas-testing attachment.

by oil and hydrogen flames of the same height; thus, supposing that the testing flames in both instances are a ¼ in. in height, and applied in the same type of safety lamp, the oil flame would produce a "cap" of $\frac{3}{16}$ in., whereas the hydrogen flame would give a "cap" of 1 in.

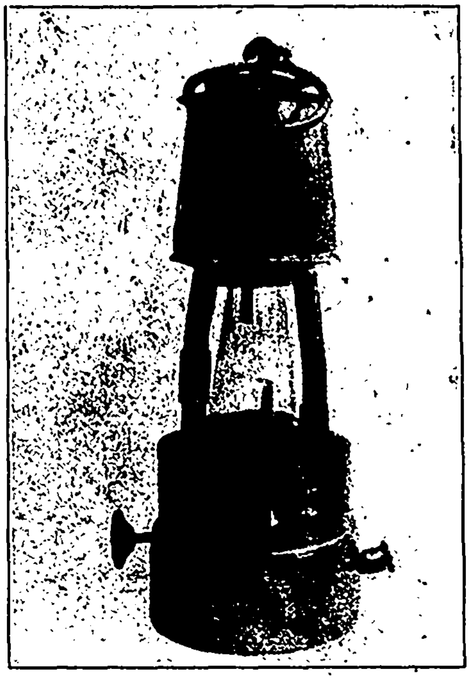


FIG. IV.—Ashworth-Gray with separate oil and alchol spirit gas-testing burners.

high. Alcohol and benzolene would give shorter "caps," but much more distinct than a colza-petroleum flame. For further proof of this rule, if we take the hydrogen flame and increase its height to $\frac{6}{16}$ in., we shall find that the "cap" for 1 per cent. of firedamp has become 3 in. high. Roughly stated, a colza-petroleum flame "cap" indicating 5 per cent. of firedamp is only equal in height to that produced by the hydrogen flame when indicating 1 per cent. of firedamp.

Having thus obtained some idea of the great divergence in the percentage of firedamp indicated by "caps" ⅛ in., $\frac{3}{16}$ in., ¼ in. and ½ in. in height, it is still necessary to ascertain which of these "caps" is dangerous, if indicated on the reduced flame of the lamps in use in

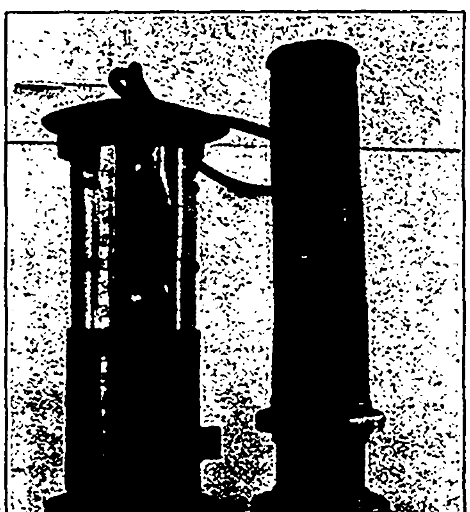


FIG. V.—G. Chesneau's alcohol spirit gas-testing lamp.

the majority of the collieries; and for information on this point we may turn to the Mines Accident Report of 1886. In this report it is stated that neither the Davy nor the Clanny lamps will show 2 per cent. of firedamp, and therefore a "cap" of ⅛ in. high must indicate some percentage of firedamp in excess of 2 per cent. The Commissioners also reported that 2 per cent. of firedamp with the addition of a normal quantity (not a cloud) of coaldust is inflammable in the presence of an open light.

As probably many others besides Mr. Hardie are desirous of having all possible information on the point of danger when both coal dust and firedamp are factors, I may state from personal experience that the flame will pass out of a Davy lamp and explode the outer atmosphere, when the latter consists of a normal quantity of coal dust floating in an air current having a velocity of six feet per second, if 4½ per cent. of firedamp is added to the mixture. The life of a lamp under these conditions is only equal to 10 seconds purchase.

Mr. Hardie refers to the Clowes and Stokes safety lamps, and therefore I have added photographs of these lamps from which he and your members will see, without any added description, that both are what is known as the Ashworth's Hepplewhite Gray deputy lamps. The addition of the hydrogen test to this lamp was originally the Ashworth and Clowes patent, Fig. 2, and similarly the alcohol detachable arrangement is the Stokes patent, Fig. 3, and not the lamp.

As to the power of these lamps for detecting gas they are as follows:—(1) The Ashworth-Clowes hydrogen test; (2) the Ashworth, Fig. 4, Pieler, and Chesneau alcohol tests, Fig. 5, and (3) the Stokes alcohol test, Fig. 3. That is to say the capacity of a safety lamp to detect firedamp is due to the heat of the flame and its non-luminosity and the hydrogen therefore possesses the highest qualification.

I need scarcely say that I shall be glad to add to these notes when requested, or to correspond with any member in relation to safety lamps.

Mr. Kirby's Detailed Figures.

The detailed figures referred to and promised by Mr. Kirby as part of the discussion of his paper on "The Influence of Government upon Mining," have been furnished and are as follows:—

POPULATION OF BRITISH COLUMBIA.

The census of 1901 is not yet published. The estimate of the Provincial Government (see argument of Hon. James Dunsmuir in Report of Delegation to Ottawa) is 150,000, including 23,000 Indians and 15,000 Japanese and Chinese, and 112,000 whites. This is undoubtedly low and will probably be found near to 125,000 to 130,000 whites.

REVENUES CONTRIBUTED TO GOVERNMENT BY THIS POPULATION.

These are Dominion, Provincial and Municipal revenues.

Dominion Revenues.—From the "Report submitted to the Lieutenant-Governor by Hon. James Dunsmuir, Premier, and Hon. D. M. Eberts, Attorney-General, on their mission to Ottawa as a delegation from the Government of British Columbia," March 15th, 1901. This at much length calls the attention of the Dominion Government to the fact that the revenue contributed by British Columbia to the Dominion is excessive, and out of proportion to that furnished by other Provinces, and estimates its amount for 1901 at $3,750,000 from the aforesaid population.

Provincial Expenditure and Revenue:—

Expenditures (from "Estimates of Revenue and Expenditure for year ending June 30, 1902"), page 2	$2,475,335 00
Supplementary Estimate No. 1 (see separate sheet)	50,440 00
Supplementary Estimate No. 2 (see Estimates for year ending June 30, 1903) page 31	192,408 00
Total	$2,718,183 00

Revenues (from "Estimates of Revenue and Expenditure for year ending June 30th, 1902"), page 1	$2,140,751 00
Less Receipts from Dominion Government and land sales	539,151 00
Revenue to be contributed by Province	$1,601,600 00
Expected Expenditures	$2,718,183 00
Expected Revenues	2,140,751 00
Expected Deficiency to increase debt	$577,432 00

This revenue contributed to the Dominion and Provincial Governments is far from being the entire amount taken out of this population for Governmental purposes. It is, however, the only portion for which figures are yet published. To it must be added local or municipal revenues amounting to a large but unknown aggregate, and the increased cost of supplies purchased in the Eastern Provinces due to the unnaturally high prices fixed by the tariff. While this is not a part of Government revenue, it is the accompanying result of the tariff tax and the same to the payer, British Columbia, as is shown by the Provincial Government in its argument to the Dominion Government,—Report of Delegation to Ottawa, March 15th, 1901. The additional cash which it takes out of the population can only be guessed at, but it is evidently a large sum.

SUMMARY.

Dominion Revenue	$3,750,000 00
Provincial Revenue	1,601,600 00
	$5,351,600 00
Local and Municipal Revenue	? ? ?
Tariff increase on Eastern supplies	? ? ?
Total cash taken out of population by Govt.	? ? ?

INDEBTEDNESS.

From the British Columbia Public Accounts for the year ending June 30, 1901, page 7, the Provincial debt funded and floating on that date is $9,619,482. The Public Accounts for the year ending June 30th, 1902, are not yet published, but as the increase between 1900 and June 30th, 1901, was $952,424, the total on June 30th, 1902, evidently exceeds $10,000,000.

PRODUCTION OF THE FIVE PRINCIPAL INDUSTRIES FOR 1901.

The first two are accurate. The others, for want of statistics, are approximate.

The Report of the Minister of Mines for year ending December 31, 1901, gives:—

Metal Mining	$15,070,382
Coal Mining	5,016,398

For the other three the only statistics so far published are those given in the 22nd Annual Report of the British Columbia Board of Trade, 1901:—

Fisheries.—Exports of Fisheries for 1901, page 65.	$2,665,915
From the proportion of total production to exports given for the salmon catch of 1900, page 57, the amount to be added for home consumption is roughly estimated as	400,000
Total product of Fisheries	$3,065,900
Lumbering.—From the same report, page 23:— The total timber cut on Crown lands, leaseholds, private property, is 223,374,723 feet, which at $7.50 is	$1,690,000
Agriculture and Stockraising.—From the same report, page 65, the exports of produce are as follows.—	
Animals and their produce	$170,218
Agricultural products	231,544
Miscellaneous	1,317 687
	$1,719,449
To which is added 50 per cent. to cover the value of the product of this industry consumed locally	800,000
Probable production	$2,520,000

EXPLANATORY REMARKS.

These statistics merely bring to a later date those of the British Columbia Mining Association in their Memorial to the Governor-General in Council, June 28th, 1901. The figures of the taxation load speak for themselves, but following their method of presentation a comparison is made between the revenue taken for government and the production of the five principal or basic industries. Since the only object is to illustrate its size, it may of course be compared with anything desired. The five basic industries are selected as the most interesting and useful basis. It is of course impossible to compare with the total production of economic wealth by all occupations, because this is unknown and if known would be less useful.

These basic occupations support practically all the others. So that the population may be roughly divided into five portions, each of which includes those dependent directly or indirectly upon one of these basic occupations, and therefore conveniently classed as a part of that industry. The mining industry, for instance, is taken to mean that portion of the population with all its minor occupations which would disappear if all the mines suddenly vanished. The comparison made is between the Government revenues extracted from that portion and the mine production which sustains it.

[NOTE BY EDITOR.—The 1901 Census figures, since published are as follows:—

Whites	132,483
Indians	25,593
Chinese	14,689
Japanese	4,507
Total population	177,272

Objects to Mr. Kirby's Paper.

To the Editor:—Having just finished reading a criticism of Mr. Kirby's paper read at the Nelson Institute meeting, allow me space to comment on same, as one interested in British Columbia mining matters.

If such a misleading and utterly unreliable paper as Mr. Kirby's is published as one of the papers of the Institute, the really valuable papers which have so far been well received will lose interest for readers who desire to obtain facts and are not looking for political fictions to the very serious detriment of the Institute. The criticism in your October number mentions "increasing paralysis" of the industry in this Province and no further notice is taken of that utterly untrue statement. The facts are that the preceding year saw an increase of copper-gold smelting facilities alone of something like one thousand tons daily all of which is fully employed. An increased copper production equal to 175 per cent. An increased gold production from lode mining alone) equal to 26 per cent. An increased silver production equal to 25 per cent Lead alone showing a decreased production of 25½ per cent, due entirely to United States politics and *not* as Mr. Kirby states to Canadian Government tactics in smallest degree. If this large increase in the earnings of the mining industry denotes an "increasing paralysis" please allow the "paralysis" to continue indefinitely. The only serious troubles in connection with the mining industry, outside the lead district, in this Province of British Columbia are (or were, having disappeared there also at this time) confined to Rossland Mining District and were caused by over-capitalization, booming, and especially, by attempted unfair treatment of the miners in the endeavor to make dividends for the over capitalized Rossland mines, undertaken by a few men of whom Mr. Edmund Kirby was certainly one It is most unfair and against the interests of all legitimate mining in the mining Province of this Dominion that such statements should be made at all, and worse if they are allowed under any circumstances to appear as being the views of the Canadian Mining Institute members, who were represented at that meeting by a small number drawn from the disaffected districts in large majority. If the paper is allowed to appear it should have a rider attached as "being the views of the Rossland Camp alone and utterly repudiated by the rest of British Columbia." I enclose my card.

A MEMBER OF CANADIAN MINING INSTITUTE.

Vancouver, B.C., 15th Nov., 1902.

A Dry Process for the Treatment of Complex Sulphide Ores.*

By H. Livingstone Sulman and Hugh Kirkpatrick Picard.

The class of ores to which our process is applicable is that in which zinc blende and galena predominate, substantial silver values being also generally present; these, commonly known as "complex sulphide ores," are typified by the Broken Hill deposits. The latter indeed are of unusually refractory character, the metallurgical difficulties attending the separation of the lead and zinc being increased by the intimate intercrystallisation of the minerals as well as by the presence of ferrous sulphides, garnet, rhodonite, etc., in considerable quantity.

It is unnecessary to review at length the many attempts to treat these ores, the more important later efforts being well known to members of this Institution; and much valuable information as to the types and values of the Broken Hill deposits is to be found in Mr. Ashcroft's paper.†

Before entering into the details of our process it is advisable to briefly indicate the methods at present employed for recovering the major values from such ores. They are all comprised under the head of concentration, the usual various types of apparatus, both wet and magnetic, being employed. Concentration, indeed, has here been carried to a state of high perfection, but however ingeniously applied, it cannot, owing to intercrystallisation and the slight differences in gravity between several of the minerals, obtain sharply demarcated products; hence it can never be more than partially successful. Even supposing the bulk of the galena to be capable of close separation, a large proportion of the silver would still follow the blende, and thus be lost in the subsequent treatment of this mineral for the commercial production of spelter.

Present systems consist therefore in the mechanical separation of the largest yield of galena which shall carry only such blende as is incapable of giving rise to serious smelting trouble. These lead (silver) concentrates are smelted in the usual manner, and constitute the only product of commercial value derivable from the ore. The other bye-products are zinc middlings, siliceous tails, and slimes; each is more or less contaminated with all the various minerals of the original ore. Thus, whilst the galena concentrates carries several per cent. of zinc, the zinc middlings similiarly hold large amounts of lead and silver, but are nevertheless of little or no present value; samples which have come before us have averaged 25 to 27 p.c. of zinc, about 12 p.c. of lead, and 10 to 12 oz. of silver. The slimes are more or less representative of the whole ore-bulk, and may even be somewhat enriched in zinc and silver; large parcels dealt with by us have been as high as zinc, 25 p.c., lead, 24 p.c., silver, 26 oz.; but the general run is lower, say, zinc, 20 to 22 p.c., lead, 17 to 19 p.c., and silver 15 to 18 oz. per ton. Slimes are also at present practically valueless. Chairmen of the various mines are apt to describe these middlings and slimes as a reproach to the metallurgist, and to picture to their shareholders visions of the potential wealth which these huge accumulations represent, realisable when once the process for their successful reduction shall be discovered.

At the various Broken Hill mines reduction work is now limited to concentration, the leady concentrates being shipped to coastal smelting works, where they are reduced to bullion with other purchased ores. Nett recoveries do not probably exceed 60 to 75 p.c. of the lead, and 55 to 65 p.c. of the silver; with the exception of small parcels shipped to Europe periodically, no zinc is recovered, though on this point it is difficult to obtain figures.

The economics of the problem have not greatly altered from those outlined by Mr. Ashcroft in 1898, when he showed that, with the then metal prices, a profit of 15s. was all that was realisable from an ore value of some £9 per ton. Since that date it is true that considerable fluctuations in prices have occurred; zinc rose to £28, but though this was a useless boon to Broken Hill, lead appreciated to £16, and for a while permitted of good dividends. This period was shortly succeeded by a still more serious fall, lead receding to a lower level in 1901 than had been known for many years, whilst silver has recently touched its lowest recorded price. Indeed in 1901 all the Broken Hill mines with the exception of the Proprietary and Central Companies were for a while shut down. Although both lead and zinc have exhibited a slow rise of late months, the general outlook cannot be considered much brighter than Mr. Ashcroft had to face in 1898. Nor do the ore supplies show any tendency to increase in value. An average of 17 p.c. lead, 24 p.c. zinc, and 13 oz. of silver per ton may now be regarded as a general type of available material.

The greatest advances of late have been in the direction of magnetic separation; various types of magnetic concentrators are now under trial and in use at the different mines, by which a closer saving is possible, and the further concentration of the middlings into what may be considered as a very inferior type of zinc blende ore can be effected. The inferiority of these zinc concentrates lies in the continued presence of considerable percentages of lead, and frequently of as much as one-third the silver originally held by the ore.

By one type of magnetic concentrator known to us the galena and quartz are obtained together, a more or less impure blende as the second product, and the bulk of the rhodonite in a third; the lead product then undergoes wet dressing to separate the silica. Starting with 100 tons of ore, about 40 tons of blende product are obtainable, assaying 40 to 45 p.c. of zinc (about 70 to 75 p.c. of the total in the ore), about 7 p.c. of lead, and from 10 to 12 oz. of silver. This product is bought in limited quantities by European smelters, but we are unable to say whether they pay for the silver or exact a fine for the lead. In this country nothing would be paid for the silver, and it is doubtful if the English zinc smelter would under any circumstances treat an ore containing 7 p.c. of lead. It is probable that on the Continent this product is mixed with pure blende ore in order to reduce the lead to a possible smelting charge. 16 to 20 tons of galena concentrates are produced after water dressing, the first product containing about 75 p.c. of the original lead and 45 to 50 p.c. of the silver. The lead product is of course subject to the usual smelting losses, which may vary from 7 to 10 p.c.

A second system, investigated rather with the idea of obtaining the richest mixed galena-blende product for our own use than with the object of effecting the sharpest possible separation of each mineral, was able to produce from zinc middlings (assaying 30 p.c. zinc, 8½ p.c. lead, and 12 oz. silver) a mixed concentrate amounting to 65 p.c. of the original ore weight, and carrying 39 p.c. of zinc, 11½ p.c. of lead, and 14½ oz. of silver; equal to total recoveries of 85½, 87, and 81 p.c. respectively. This was obtained by the mixing of a more with a less leady concentrate.

The foregoing is a brief sketch of the recoveries now obtainable in Australia, and given to indicate the possible scope of inventions for remedying the unsatisfactory results realised even by the best systems of concentration.

In the cases of the many huge deposits of complex ore known to exist in other localities, but hitherto unworked, present Australian methods would not necessarily be followed as preliminary steps in our own or perhaps other processes. The Broken Hill products and accumulations are the outcome of evolutionary concentration methods; but in many instances complex ores are capable of direct reduction without the need of mechanical separation, or at most but that of barren silicious gangue if desirable.

*From the Transactions of the Institution of Mining and Metallurgy.
†Transactions, Vol. VI, p. 282.

In our search for a suitable reduction scheme we desired to confine our attention to dry processes in order to avoid the apparently insuperable difficulties attendant upon all wet methods. When it is remembered that the weekly production of ore from Broken Hill mines amounts to some 20,000 tons, and that the maximum density of zinc sulphate liquors practically allowable cannot reach much over 20 p.c., the task of dealing with the huge necessary bulks of solution, and of leaching, filtration, concentration, and precipitation, operations on such becomes appalling. Even then (electrolysis being as yet unsuccessful with aqueous zinc solutions) the result is only a product requiring dry distillation. Indeed, it becomes evident that the difficulties of wet recovery processes only really commence when the solution of zinc or other metal has been effected.

Dry processes are of course no novelty, as witness the efforts of the Smelting Corporation, of Ellershausen, Armstrong, Angel, Claus, and many others in this direction. But we believe we are correct in saying that hitherto all dry processes have started with the intention of recovering the lead and silver in the first instance, whilst obtaining the zinc as a volatilization, or as a slag, or other residual product, for subsequent re-treatment. We cannot, however, include in this catagory the recently introduced Phœnix process, which, if alone from the daring ingenuity displayed, is worthy of a class to itself.

In fact, zinc has always been considered as the objectionable element in the ore, and the efforts of inventors have almost invariably been towards its early elimination, with the hope, never yet realised, of a subsequent economic recovery. The reasons for this attitude are easy to discern ; these ores have always been considered primarily as *lead* ores, whilst those interested in the zinc industry, who may have directed attention towards such, have condemned them at once as unsuitable for treatment in zinc retort furnaces, owing to the fatal presence of lead in any product obtainable by dressing.

The difficulties in distilling leady zinc ores are shortly these. Foremost comes the destruction of the retorts by the reduced lead ; this occurring mainly during the stirring out of the seconds from the pots whereby the metallic lead is oxidised to litharge, with the inevitable result of the rapid slagging up and holing of the retorts. Even could this be overcome, it is found in ordinary practice that lead tends to volatilise with the metallic zinc vapours in such quantities as to materially damage the spelter produced. Finally, if lead were capable of complete elimination from the ore, we should still have the question of the silver to deal with, which, as we have shown, largely follows the blende, and would, in the usual routine, be lost both in the seconds and (similar to the lead) by partial volatilisation in zinc vapours.

We may point out that gold also escapes under such conditions, and it was in regard to the recovery of this metal from zinc precipitates obtained from the cyanide process that we were led to devise a method for obviating such losses.* Indeed, the success of this method induced us to further apply the same principles to the treatment of complex sulphide ores. Our idea was therefore to treat these primarily as *zinc* rather than as *lead* ores ; and to obviate the difficulties encountered when the material is so considered.

It is necessary to draw particular attention to the rule invariably adhered to in zinc smelting, viz.:—To employ nothing except anthracite as mixing coal ; it being supposed that the gases resulting from the carbonisation of other classes of fuel cause losses in spelter. Moreover, other fuels are (reasonably) considered likely to lead to the slagging of retorts during distillation,† a danger to be avoided as far as possible ; even good (roasted) blende ores always contain much slag material (Fe_2O_3, FeS, SiO_2, etc.), whose baneful influence it is sought to reduce to a minimum by the addition of a very large excess of coal over and above that required for reduction purposes ; such excess acting as a mechanical diluent. As the amount of mixing coal used in general practice varies from 50 to 100 p.c. (on the roasted ore), it is essential that this should contain the least possible ash. Further, slagging troubles would be far more pronounced if an ordinary zinc distillation of roasted Broken Hill ore were attempted ; as, apart from the lead and ferrous sulphides, we have also the maganous oxide, which yields a very fluid slag with silica, and much garnet. As the result, however, of our experience in the distillation of zinc-gold material, we formed the opinion that the use of a strongly coking coal would, by holding dangerous materials suspended in its pores, overcome the objections to the presence of lead and other slag formers, and permit of the distillation of complex blende-galena ores as ordinary spelter-yielding material. In this factor alone has lain our main departure from previous methods, and extended practical trials have proved our anticipations correct. It is unnecessary here to further trace our progressive trials, and we now consider the completed process.

It commences with the usual preliminary roast of the crushed ore, slimes, or zinc-lead concentrate, in a reverberatory furnace, to a product which shall contain, preferably, not more than 3 p.c. of total residual sulphur.

The roasted ore is next mixed with only about 20 p.c. of crushed *coking* coal, and the mixture briquetted in any suitable type of machine. As a binding agent pitch, or other carbonaceous material, is added : lime or other chemical binders are undesirable as they tend to permeate the whole briquette with slagging material, and also, from some unexplained reason, to cause lead losses. Further, the admixture of a carbonaceous bond aids the bituminous coal in forming the cohorent coke which not only the distillation but the subsequent lead-smelting operations demand. The briquetting plant is of a standard type consisting of a disintegrator, into which the roasted ore, coking coal, and pitch, are introduced, a pug-mill, press and table, together with the usual intermediate elevators and a conveyor belt for delivering the finished briquettes to the retort house.

The briquettes are then submitted to distillation in an ordinary zinc retort-furnace. Those used by us at the Emu works in South Wales are of the old-fashioned hand-fired Welsh-Belgian pattern, without regenerators, and using hand-made pots. Each contains 144 retorts in 6 rows, the lowest being cannon pots : a retort takes about 15 briquettes, the total capacity of a furnace being seven tons.

This type of furnace is, nevertheless, not the most suitable for our requirements, as six rows of retorts one above the other cannot be uniformly heated by bottom firing. The lower row of cannons is apt to be damaged by excessive heat if the uppermost rows are to receive an adequate temperature ; too sharp a heat is also detrimental to the best extraction. In most spelter works employing this type of furnace the difficulty is avoided by using the lower rows for the distillation of "hard" material (roasted blende), whilst the upper are employed for "soft" (calamine) ores. On uniform material such as we treat a compromise must be effected ; we therefore work to obtain the best results from the three intermediate rows. These give us a 70 p.c. zinc recovery on 26 p c. briquetted ore, whilst the lower and upper rows yield a few per cent. less.

For these reasons the gas-fired 3-row type of furnace has been adopted for our process at Cockle Creek, as it permits of absolute uniformity of heating, and, therefore, of the maximum recovery. Hydraulic-pressed retorts, so universally used on the Continent and in America, are also employed in Australia. In ordinary zinc-smelting practice the roasted ore and anthracite duff are hand-mixed in front of each furnace, the damped power being then charged into the retort ; by our method the mixing is more efficiently performed in the briquetting

*See Journ. Soc. Chem. Ind. xvi. p. 967, also Trans. Inst. Min. Eng., March 20th, 1898.

†Louis and Schnabel II. 89.

plant, and the charging of the briquettes more easily effected by means of a shaped iron paddle.

Once charged, the procedure for the recovery of the zinc is identical with ordinary practice, although the action within the retort is of a different character. The briquettes, as they reach the temperature of distillation of coal, coke into coherent masses, with evolution of volatile hydro carbons. Reduction of the lead simultaneously occurs, the minute metallic particles entirely premeating, and being held up in the pores of the coke, whilst, at the higher temperature shortly afterwards reached, zinc oxide is reduced, and yields metallic zinc vapours, which are condensed in pipes, these are tapped at intervals in the ordinary way. The distillation occupies the normal time.

We draw attention to the remarkable fact first noticed at the outset of our experiments, now confirmed by some years' experience, that, whereas in ordinary practice lead distils to a marked extent in zinc vapour, in our process the whole of the lead, as also the silver and gold, is retained by the coke. The latter thus appears to exert an actual physical retardation of the volatility of lead in a slow current of zinc vapour. So definite is this advantage, that we find the spelter thus produced from Broken Hill ores to be of exceptional purity, averaging 99 p.c. of metallic zinc, and commanding prices equal to that of the best brands produced from lead-free ores. This spelter is already in considerable demand, owing to its low lead tenour, which does not often exceed ½ p.c.; it can thus be employed for the manufacture of the finer kinds of brass, for which the ordinary brands, containing from 1 to 2½ p.c. of lead, are useless.

The zinc having been recovered, the seconds are withdrawn from the pots (pipes and luting clay having been removed, and sweeps collected) and discharged into the caves, whence in usual practice they would be dumped. But, the seconds resulting from the treatment of such complex sulphides ores still retain the major values, in the shape of all the lead and silver originally present. These are obtained in the coked briquettes in a form eminently adapted for recovery in the subsequent lead smelt. The zinc retained in the seconds does not exceed the amount allowable in ordinary practice, and presents no difficulty in obtaining of the usual bullion recoveries. The residual carbon in the seconds is, of course, a considerable source of heat in the after smelt, and is therefore not lost, as it is in the case of ordinary zinc seconds.

By this simple operation we are enabled to convert a complex ore into a simple silver lead product, amenable to normal reduction methods, having already recovered the bulk of the hitherto objectionable zinc as high quality spelter. The final operation for the recovery of lead and silver as base bullion being the ordinary one, conducted in the usual types of plant, both in South Wales and Australia, does not call for further description here.

Indeed, we may remark that the few operations which constitute our process are all effected in well-known and standard types of plant, and that no fresh item of apparatus, concerning which there might be doubt as to costs or method of working, has been found necessary. Roasting, briquetting, zinc-distilling and lead-smelting methods and costs are fully known. Throughout the operations, nothing beyond coal and binding agent and the usual lead-smelting fluxes are employed. It is somewhat surprising that so simple a method of treatment has been so long overlooked. The system is compact, and permits of economies when zinc and lead-smelting processes are thus linked together, not realisable by either separately.

In general, blende ores containing less than 40 p.c. of zinc are not profitable to treat. Such if mixed with 80 p.c. of anthracite duff would yield pot material containing little more than 22 p.c. of zinc; whereas a zinc-lead concentrate, containing say 35 p.c of zinc, requires, by our process, the addition of only 25 p.c. of mixing coal and binding material, and produces a briquette carrying 28 p.c. of zinc; with the additional advantage of yielding a residue containing profitable material. It is possible to treat a 35 p.c. concentrate for its zinc alone, the lead and silver remaining in the residues as profits subject only to recovery costs, whilst the fuel values remaining aid in reducing these.

Recoveries. Lead, silver, and gold, as before stated, are recovered in the seconds in full, the lead of course is subject to the normal smelting losses, just as in the treatment of ordinary lead concentrates, though the Huntingdon and Heberlein, and Carmichael, processes, claim to reduce such losses to about 2 p.c., and we believe these claims to be well founded.

Bearing in mind the fact that the seconds hold all the lead in the *metallic* condition, the question naturally arose as to whether smelting was the most economical method of recovering this metal and the silver. We devoted considerable attention to the mechanical separation of the reduced lead, but unsuccessfully. The metallic particles and prills are so exceedingly finely divided throughout the carbonaceous sponge that any method of water dressing or concentration results in heavy loss, nor did oil concentration give any better results, owing to the excessive amount of carbon also taken up. On the whole, smelting was adopted as the simplest, safest, and most usual method.

With regard to zinc recovery, the spelter yields are practically the same as those obtained in the ordinary treatment of blende ores. To reckon in percentages is somewhat illusory, as these depend naturally upon the original zinc contents of the ores treated. With a zinc-lead product carrying 40 p.c. of zinc no difficulty is experienced in obtaining a recovery of 80 p.c. of that amount, whilst, with a 25 p.c. material, 70 p.c. may safely be reckoned upon in modern furnaces. Late advices from Cockle Creek inform us that the recoveries of both lead and silver in the seconds are complete, and that the zinc production already exceeds 70 p.c.; Slimes averaging 25 p.c. of zinc being the raw material used. With 35 p.c. material we have every reason to anticipate an 80 p.c. recovery. The pot consumption is quite normal there, mixing coal is obtainable at lower rates than are available to us in South Wales. Fireclay of good quality for the manufacture of hydraulic pressed retorts is also available on the spot; and we have used trial lots of this material for some of our retorts in South Wales, with excellent results. The works at Cockle Creek are the first producers of spelter yet installed in Australia.

In ordinary zinc practice, it is not found economical to force the extraction below a certain point, as the increased time required not only reduces the output of the furnace, but, with the higher temperature necessary, the pot censumption becomes unduly great. The zinc usually left in the seconds varies from about 5 p.c. to 8 p.c. Our working costs are also normal; no difficulty is experienced in calcining the complex ores to the sulphur standard usually required for blende, the zinc furnaces do not demand any greater attention or further hands, whilst labour in retort charging and discharging is materially lightened by the use of briquetted material. Briquetting charges are, of course, additional, but are to some extent balanced by the far smaller consumption of mixing coal, and by the economical handling of material during the final lead smelt.

A point to which attention will doubtless be directed is that of pot and pipe consumption. The average life of our pots, even though used for distilling such highly refractory material, is fully equal to that of the retorts used for good blende and calamine ores according to usual methods, being from five to six weeks each. Our present consumption per day is 3.7 pots per furnace. The cost of our hand-made pots is about 6s. apiece. This is admittedly high, even for England, and hydraulic-pressed retorts, having a longer life, requiring less clay, and demanding a lesser distillation temperature, can be produced for 3s. each.

A certain proportion of "fines" is inevitably produced in raking the briquette seconds from the pots into the caves beneath the furnace house. These are separated, damped with water, and rebriquetted for lead-smelting purposes from time to time at a cost of about 2s. per ton of fines.

We append a schedule of cost incurred during the late treatment of a parcel of Broken Hill slimes, averaging 25 p.c. of zinc, 24 p.c. of lead and 26 oz. of silver per ton.

Calcining.—Hand roasting of such material to 3 p.c. of total sulphur or slightly under in South Wales costs about 9s. per ton, whilst mechanical roasting in the Godfrey furnace amounts to about 6s. 6d. Other forms of mechanical calciners, such as the Brown Straight Line, will roast complex sulphide ores to this limit at even lower cost; but at present the hand-calciner and the Godfrey appear to yield the denser product and also to be preferable in other respects. The question of the best form of calciner is not fully settled, but we select the Godfrey costs as those most lately obtained.

COSTS PER TON OF ORE TREATED.

	S. D.	S. D.	S. D.
Ore drying.—Screening and crushing of lumps, and wheeling....			2 6
Calcining.—Fuel, labour, maintenance..			7 0
Briquetting.—(30 tons of roasted ore per day)—			
Labour.—1 pressman at..........	5 0		
3 belt men "	5 0		
2 labourers "	3 9		
Boilerman "	4 9		
		32 3	
Coal.—			
1 ton for boiler..............		8 6	
6 tons for mixing, at 8s. 6d...		51 0	
Pitch.—1½ tons at 45s..........		72 6	
Stores.—Oil, etc.................		1 3	
Cost of briquetting 30 tons =		165 6	
= per ton ore			5 6¼
Retorting.—(Costs per furnace per 24 hours).			
Labour.—2 foremen at 6s. 8d. =	13 4		
2 second hands at 5s. 6d.............. =	11 0		
2 helpers at 4s. 3d... =	8 6		
4 cave men at 4s. 3d. =	17 0		
1 pipe chipper (boy)....	1 4		
General labour	5 9		
		56 11	
Pottery.—3.7 pots at 6s. ..... =		22 3	
9 pipes at 2d .... =		1 6	
Coal, for firing 3¼ tons at 9s. 6d. =		30 10	
Stores, luting clay and repairs....		4 6	
		116 0	
Contingencies, unoccupied pots, dead-fires, etc., add 5 p.c... =		5 9½	
		121 9½	
For charge of 7 ton briquettes = 5·6 tons of ore = per ton..			21 9
Yard and general labour			1 6
Re-briquetting of "fines," at 2s. per ton—Seconds contain 30 p.c. fines; on 80 p.c. of seconds.......... =			5¼
Smelting costs on seconds (see p. 12).—(Seconds amount to about 80 p.c. on the original ore.)			
Smelting per ton seconds........	12 6		
Refining, sales, brokerage, insurance, etc., at £2 per ton of Bullion produced, at 26 p.c. bullion	10 5		
Per ton of seconds		22 11	
= per ton ore................			18 4
Lead smelting losses—			
2.8 units of lead (= 10 p.c. on residues) at 2s. 3d...........			6 4
5 p.c. silver = 1¼ oz. at 2s. 1d.			2 8
Office management and assays—dependent on size of installation, say			5 0
Total cost of treating 1 ton of ore......			71 1
Recoveries—			
Zinc, 70 p.c. (of 25 p.c.) = 17·5 units at 3·65s. =			63 10½
Lead, 90 p.c. (of 24 p.c.) = 21.6 " 2s. 3d. =			48 7¼
Silver, 95 p.c (of 26 oz.) = 24.7 oz. at 2s. 1d. =			51 5½
			163 11¼
Less costs			71 1
Realisations... ....£4			12 10¼

From which must be deducted cost of transport of slimes or cost per ton of ore.

In regard to the first four items the above costs are certainly capable of reduction.

In South Wales we have at present no lead-smelting plant for spot recovery of the seconds values, but dispose of these to local reduction works according to their assay values upon the usual scale of returning charges. The erection of lead-smelting plant at our own works is under consideration, in order to save these extraneous profits and to obviate freight to the smelters. In Australia, the smelting plant is that in ordinary use for reduction of the lead concentrates, etc.

The work outlined has occupied our attention for some years past, during which we have carried through a large number of experiments in the laboratory, in small works specially erected in Surrey, and finally at the Emu Works in South Wales, where large scale furnaces have been running for the past year as a commercial undertaking. We have there treated over four thousand tons of Broken Hill slimes besides many other parcels of complex sulphide ores. The recoveries of lead and silver have been practically complete in all cases, whilst the spelter yields have varied from 60 p c. to 80 p.c., according to the original zinc contents.

Complex ores containing copper present no further difficulties as to retort treatment: the copper, of course, remains with the lead and silver in the seconds, and is thence obtainable by modern copper-lead smelting methods.

Summarising our process, it may be said to consist in the holding up of the minute particles and prills of reduced silver-lead in a coherent but still highly porous coke or carbonaceous sponge during zinc distillation; thus preserving the retorts from contact with lead or other slag material, and ensuring the all but complete non-volatility of the lead and silver in the liberated vapours of metallic zinc.

In spite of its apparent simplicity, our process has been found capable of complete patent protection in the principal countries and colonies of the world; whilst the grant to the United States, German and Scandinavian patents, may be taken as evidence of novelty.

Gold Dredges—Their Construction and Manipulation.*

By DAVID K. BLAIR, Consulting Dredging Engineer.

In this paper it is not the intention to traverse gold dredging from its elementary stages, or to deal to any extent with its aspects historically—this has already been done by various authors—but simply to give as concisely as possible, in the limited time at our disposal, a description of the "Bucket Gold Dredge" as we find her at the present moment, and the general principles of her construction and manipulation, the accidents to which the various parts are liable, with their cause, effect, and remedy; avoiding, as much as possible, technicalities of a bewildering nature.

To many the idea of dredging suggests the necessity of a river, lake, or harbour, or some place where it is possible to float a fair sized ship—in fact some navigable place; but if you told a large percentage of the well-informed of the day that it was possible to dredge an ordinary city street without any serious difficulty, with a modern "Gold Dredge," your assertion would be considered impracticable and ridiculous in the extreme. However, at the present moment in Australia dredges are working quite as dry places with comparative ease, and plants exist that work without water at all; but it is not intended to deal with them in this paper, but to confine ourselves to the floating "Bucket Dredge," and more especially to the "paddock" type of this class.

*Paper read before the New South Wales Chamber of Mines.

The gold dredge of the present day is practically the dredge we see every day at work in our harbours and rivers, deepening channels and berths for shipping, with gold saving appliances added.

The spoil of the material lifted in the case of the harbour dredge is discharged into a hopper forming part of the structure of the dredge herself, in which case the dredge is fitted with propellers like an ordinary steamship, and after filling her hopper, slips her moorings, and steams out to sea, where the doors fitted to the bottom of the hopper are dropped open, and the spoil discharged into deep water; the doors are then closed by means of powerful winches, generally fitted with "Napier differential brakes," which act automatically, and the dredge then steams back to her working ground, picks up her moorings, and repeats the process: or the dredge may not be of the "hopper" type; in this instance, the spoil is discharged into "hopper" barges, self propelled, or towed, and deposited where desired in a similar manner to that above described; the dredge herself remains on her working site, and is kept supplied with barges for removing her spoil. Little or no dredging time is lost by working on the hopper barge system.

There is no reason, nor would it cause serious delay, for dredges working at the deepening of navigable rivers, or other places found to be auriferous, from passing their spoil over gold saving appliances before discharging it into the hoppers, and the working expenses defrayed or partially defrayed, if not a profit made by the gold recovered.

The gold dredge lifts the spoil and mixes it with a sufficient quantity of water to efficiently wash it, passes it in this condition over gold saving appliances and discharges it over the stern as treated material, namely, "tailings." Briefly, the gold dredge simply lifts the material at the forward end, washes it and discharges it astern; she does not make the water in the river, if she is working in a river, any deeper, she only cuts out an excavation to suit her own requirements, which she carries along with her as she goes. I mention this latter point because many are of the opinion that dredging a river implies deepening it, even dredging it for gold; but anyone who has seen any of our rivers which have been operated upon by a gold dredge, knows, it is not so.

I am not in this paper going into details of what is or what is not suitable ground for "bucket dredging." I shall start by placing gold dredges into two classes, namely:—"River" and "Paddock" dredges, disregarding any elevating gear they may or may not have, and give the following definitions of the two classes:—

A "River" dredge is a dredge designed to work with some depth of water underneath her, and is not called upon to cut her own flotation; she is, therefore, not provided with a projecting ladder to eat into banks, or with sharpened bows to work into corners, but is, as a rule, built square across the bows, especially if working in a current, such as runs in the Molyneux, in New Zealand; for the practice there has proved that a square nosed dredge remains steadier in the current; and does not "yaw" about so much as a sharp-nosed one. Of course they offer a much greater resistance to the current and require very heavy lines to hold them, but as a dredge is not built for speed like a torpedo boat resistance is not taken into consideration to any extent, beyond the usual practice of making the floor of the pontoon take an upward curve at the bow.

In Australia, at present, we have not such a thing as a dredge of the "River" class, all the dredges being "Paddock," and it is with this latter class that I propose to deal.

A "Paddock" dredge generally commences her existence by being launched into a hole containing water sufficient to float her. This hole may be a water hole in the bed of a river or elsewhere, or may be an excavation specially prepared for her reception anywhere; and from this hole or "paddock," as it is called in dredging parlance, cuts her own way over the claim.

Assuming that the ground has been inspected by a competent engineer, and in his opinion the conditions are suitable for dredging, it is of the utmost importance that the dredge should also be suitable for the ground, that is, be capable of bottoming at any part, dealing with timber or other obstructions that may present themselves, and efficiently treat and recover as much as possible of the precious metal contained in the material lifted. She must also be so constructed that her draught of water will not prevent her floating with ease over the shallowest portions of the claim without having to lift "bottom" to do so. A "Paddock" dredge should draw as little water as possible, and the draft should not exceed 5 ft. even in large dredges; a fair average draft is about 3½ ft. to 4 ft. with a day's (twenty-four hours) fuel on board and dredge working.

The first point for the designer to decide is the dredging depth, this to a great extent fixes the length of the hull, and is measured from the water line of the "dredge" to the cutting edge of the bucket when the ladder is lying at an angle of 45° to the water line. Some dredging engineers measure what they term the "maximum dredging depth" at an angle of 55°; this you will see makes a considerable difference, and it might be as well to ask the angle when buying, or when having a dredge designed, to specify the angle. Up to the present there is no fixed standard angle.

The next point is the material to be used in the construction of the hull. In Australia timber hulls are used solely, also timber superstructures for carrying the machinery. In some dredges, however, steel gantries are used, built of angle bars and plates, and make a very light and neat structure; these will be be dealt with in detail later on. The timber used for the framework is Colonial hardwood, generally of kinds procurable in the district in which the dredge is built, and she is planked and decked with similar timber. In a number of instances oregon, and in some cases kauri, have been used for planking and decking. There are places in Australia where, owing to white ants and other destructive insects, it would not be advisable to use timber in the construction at all, and it would be necessary to adopt iron or steel in its place. For several reasons steel is the material to be used in South Africa for hull construction. In New Zeland, most of the old type of dredges were built of steel or iron, but out of some two hundred built within the last five years, there has not been, as far as I can ascertain, a single steel hull built for use there. The material used for hulls in New Zealand now being Australian hardwood (blue gum chiefly) for the framework and super-structure, kauri planking and decking. Kauri is sometimes used in the super-structure. Red pine and other local timbers were used in "boom time" and on cheap work, but they are totally unsuitable. I shall not touch upon steel hull construction, but confine my attention to timber hulls only.

The main point in a hull is to make it as stiff as possible to resist the concussion and vibration it has to withstand. Few people realise the intensely severe nature of the work dredges on our rivers and flats have to perform. Immense hardwood logs sixty or seventy feet long (with perhaps a mean diameter of four feet), which have been buried in the wash for years and covered up with gravel and *debris* of all kinds by successive floods, have to be lifted and carried clear of the dredge. Huge boulders have to be negotiated to permit the dredge to pass. Floods at times rising thirty or forty feet rush past the dredge at a perilous speed, carrying with them islands of *debris*; and sometimes the dredge next above you joins in with the flood and pays you a visit. The snapping of a line, a blow from a log of floating timber and your dredge is doomed. And, lastly, what we are now suffering from—drought with all its concomitant troubles.

If the ordinary mining speculator who does so much general all-round growling and fault-finding would look at some of the above points in a reasonable light, his criticism would assume a milder form, and he would admit that engineers, dredgemasters, and others engaged in the industry had a lot to put up with, and that their efforts to recover the gold that all other systems had failed to get, are worthy of at least a little consideration.

From the above the necessity of a stiff construction is obvious.

The bows (noses) of all "Paddock" dredges should be well rounded to permit of being easily manipulated in a corner, and should also be more heavily planked and framed than the other portions, so that she may not be damaged by striking the face, as the dredge surges at her work. Very often the bows are sheathed with steel plates as a protection against blows and chafing.

The bottom of the hull at the forward end should be sprung or bevelled upwards for clearance and handiness in working, and the bottom from the bows aft to the position of the ladder at her "maximum dredging depth" should have the thickness of planking considerably increased to obviate accidents through logs being caught in the buckets, and by them being dragged upwards through the bottom. This type of accident is by no means infrequent.

For clearness in describing I shall refer to the dredge complete as the "dredge;" to the two pontoons (namely the "port" and the "starboard" pontoons) tied together to make one structure as the "hull." Amongst dredging hands the "hull" is usually alluded to as the "pontoon" or "pontoons," but in describing the construction it is necessary, to avoid confusion, to discriminate the terms used. The ordinary hull consists of two long narrow pontoons joined together for about a third of their length by a third small one equal in width to the width of the ladder well required. The two longitudinal sides of the third small pontoon are really a portion of the inner or well sides of the two main (or long "pontoons") before mentioned. The floor and deck beams where the three pontoons are tied together are in single lengths and are common to the three pontoons. These three pontoons form the "hull." Besides the floor and deck-beams a number of very much heavier beams also run across the entire width of the three pontoons alongside the floor and deck beams; and these are lattice braced to form thwartship girders, to overcome the tendency of the structure to "sag" inwards towards the ladder well or "hog," according to the distribution of the weights on board. In a similar manner the stringers, girders, etc. (according to the design adopted), and planking in this inner (or well) side of each pontoon are run its entire length. This construction forms the hull into three distinct water-tight compartments, namely, the two main pontoons and the small connecting pontoon. The two main pontoons are, (or ought to be), each subdivided into three water-tight compartments, making in all seven water-tight compartments in the hull. Unfortunately both here and in New Zealand, from motives of economy, and through the over-ruling power possessed by individuals totally ignorant of what is required (and what is not required), these very necessary safeguards have been omitted, and the result is that a number of our dredges have had a trip to the bottom of their paddocks, and now carry with them the effects of their immersion in the shape of twists, bends, cracked castings, machinery out of line, besides other defects added to all of which is the cost of lifting, loss of working time, etc., while current expenses are running on just the same without the necessary gold coming in to meet them.

There are several other types of construction adopted by different designers, but in all the general principal of construction is as above described. I shall briefly describe a few of them.

The Double Skin.—In this method of construction on the sides of the dredge, the outside planking is of the usual sizes, but the fore and aft stringers are done away with, and in their place very deep planks attached to the frames forming an inner but not a water-tight skin, the outside planking alone being caulked. The inner planking is secured by long vertical drift bolts. The "inner" and "outer" skins are also bolted together through the frames. For this form of construction the timber should be very well seasoned, or the shrinkage will be considerable in the wide inside timbers. The bottom, and deck are of single planking of ordinary construction.

This is a light and simple form of construction, the principal faults in it being the difficulty of locating and stopping a leak, owing to the internal side planking and the absence of diagonal bracing where the machinery happens to be heavy.

The Fore and Aft Keelson.—This is a method of construction in which the thwartship beams and floors we usually see in a ship are done away with, and a series of keelsons and fore and afters run the entire length of the pontoons in place thereof. The bottom and deck planking is laid athwartships, wide planks being used for the purpose. No side frames (or ribs) are used, but a number of stringers run the entire length of the pontoons. The side is trebly planked, that is, the planking is put on in three courses. The first is put on diagonally, at an angle of about 45° to the deck line. The second at about right angles to the first, and the third, or outer planking, horizontally as in ordinary ship work. The outer planking is caulked and felt, or "chenam" is generally interposed between each course of planking. The diagonal seams are not caulked.

Like the last method of construction, the dfficulty of locating and stopping leaks occurs. The thwartship planking is also a very weak point. It is also a simple form of construction, and quite a number of dredges have been constructed here on this principle, but only two, as far as I know, in New Zealand have heen built on this plan.

The Braced Stringer.—In this method three stringers of different sections run the entire length on each of the four sides of the pontoons the one on the bilge being generally square in section. These are bolted to the frames (or ribs) and stiffened by diagonal bracing checked on to their faces. On the inside the planking is spiked and bolted to the outer side of the frames (or ribs) and laid horizontally in one thickness. The floors are bolted to the frames (or ribs) and the deck beams to the frames (or ribs) as well as to the stringers.

This construction is a strong one, and makes an excellent job, but as it involves a lot of joiner work it is rather expensive, and it is not one that can be placed in the hands of amateurs. It must be performed by first-class tradesmen.

The Wedged Stringer.—This method is identical with the above, with the exception that long double wedges are used between the stringers and the diagonal bracing dispensed with. The bad feature in this construction is the wedges. The excessive vibration on a dredge when working causes these wedges to work loose, and they are then practically non-existent, unless they are carefully watched and kept driven hard home.

The Girder Side.—Several varieties of this form exist, but they are more or less complicated and expensive to make.

The latest New Zealand design consists of a top and bottom member of a heavy flat section. The cross bracing is used in such a manner that the lower end of the brace butts against the floor and the upper against the deck beams. The cross braces entering into and mutually assisting each other in forming a compact and highly efficient design. The top and bottom members of the girder are further tied together by "king bolts," situated in pairs in the diamond formed by each pair of cross braces. The frames (or ribs) are bolted to the outer face of the cross bracing to permit the "king bolts" to draw up, from time to time, any play that may appear in the joints of the girder, due to shrinkage in the timber, over-straining, or other causes. The planking is spiked to the ribs as in ship work. These girders extend the full width of the pontoon forming the four sides; and four or more of similar design run athwartships of the pontoon, namely, one forming the after end and one at the end of the well, each extending the full width of the hull, and one shorter one, or two in the case of longer pontoons, athwartships in each pontoon.

This construction reduces all the defects in the others mentioned to a minimum, and possesses as well the feature of being a simple one, that is, one in which the efficiency is great, compared with the cost of labour in obtaining it

There are other constructions in which a series of girders of complicated designs run fore and aft through the centres of the pontoons, as well as forming the sides, but, in my opinion, the quantity of timber used and the labour required in their construction makes them very expensive to build, and does not warrant their adoption for this purpose. There is, however, no doubt that they possess the feature of strength in a marked degree, but are unnecessarily ponderous. These examples just mentioned practically embrace those in general use by dredging engineers, but others exist, such as the "cellular" type, etc., but as a rule their novelty far exceeds their utility.

All the above types are stiffened laterally (that is, athwartships) by diagonal or cross bracing, and are provided with hold pillars to support the weight of the deck on which the bulk of the heavy machinery is placed, and are also capable of being sud divided into any required number of water-tight compartments, and should be sub-divided in such a way that any one, or even two compartments, could be filled with water without sinking the dredge. Dredge owners, when placing a dredge in the hands of an engineer to design, should stipulate that water-tight compartments should be incorporated in the design, and also that these compartments should be practically tested, that is, filled with water and the effect noted. The test would cost very little, and the owners would, at all events, be satisfied that with ordinary care the chance of their dredges sinking was a remote one. Within the past two years, to my knowledge, no less than seven dredges out of a working total of thirty sunk, and two of these performed the feat twice, and quite a number of others had some very narrow squeaks for it. I mention these facts here to emphasize my remarks on the necessity of sub-dividing dredges into water-tight compartments by the simple and inexpensive method of a few water-tight bulkheads. Had the dredges alluded to in this been properly sub-divided with a few water-tight bulkheads their immersion would never have occurred.

Another point in bulkheads is that they stiffen the hull laterally (that is, athwartships), and if employed do away with a large amount of the transverse bracing, and as all the machinery, with perhaps the exception of the centrifugal pump, is usually on deck, there is no obstacle in the way of placing bulkheads or lateral bracing where required. One important point to be noticed regarding bulkheads in timber pontoons, however, is that ventilation must be provided for each compartment, in addition to the usual small hatchway.

Having dealt with the pontoon itself, the next consideration is the superstructure which consists of "tumbler framing," "gear framing," "hog framing," screen or sluice box framing," "gantry," etc., etc.

The "tumbler framing" consists of very heavy uprights and beams, cross diagonally braced and well tied in every direction with heavy tie bolts, and as it also supports the ladder with its tumbler and buckets, as well as the main tumbler with its gearing, the structure requires to be exceedingly strong and rigid to withstand the shocks it is subjected to.

The "gear framing," in construction, is similar to the tumbler framing, but considerably lighter. It is usually braced athwartships to the tumbler framing. As it supports all the intermediate gearing and shafting it also requires very rigid bracing.

The "hog framing" is constructed of vertical posts, really Samson posts, or lattice braced framing of the "A" or other types, erected where deemed necessary. Iron or steel rods, or heavy steel ropes provided with tension, or rigging screws lead from the top of these posts or frames forward and aft, for the purpose of counteracting the tendency long dredges have of hogging, that is, dropping at the stem and stern, but it is sometimes dispensed with in short dredges. The hog framing is also used as a derrick to support the elevator in dredges carrying elevators.

The "screen framing," where a screen or screens are used, is very much the same in its principle of construction as the tumbler and gear framing, and the sizes of the scantlings used are the same as in the gear framing, perhaps a bit lighter.

The "sluice box framing" follows the general design of those just mentioned, but is very much lighter still.

The "gantry" is a very important part indeed of the structure of the dredge, and more so of the "paddock" dredge, whose well, owing to the necessity of having the ladder projecting in front, must be left open forward. The gantry, therefore fulfils a dual duty, that is, it ties the two "pontoons" together, as well as sustaining a very large proportion of the weight of the ladder, amounting to many tons.

A "gantry" requires to be extremely rigid, and besides possessing the features mentioned, must also be capable of overcoming the tendency the pontoons have of sagging inwards towards the well caused by the excessive weight of the ladder being concentrated on one central point forward in the weakest portion of the dredge's structure, and for obvious reasons its weight must be centralised there or thereabout. This strain can, however, to a certain extent, be neutralised by the distribution of machinery on board. The scantlings in the gantry, if of hardwood, are very heavy, and as a rule are of similar size to those in the tumbler framing.

In an ordinary 4½ft. bucket dredge this weight varies from twenty-five to forty-five tons, according to the dredging depth and application of the strain.

The remarks I have made practically embody concisely the salient features in the construction of the hull and super-structure of a modern gold dredge built of timber. I shall now deal with the machinery to be erected on the hull.

The two most important factors in dealing with the machinery required are the dredging depth and the capacity; this allows us to arrive at the power of engine, size of buckets, etc. Before going further it might be as well to define the term "capacity" as applied to a dredge. Capacity, or nominal capacity, is the actual amount the dredge can lift running full buckets, with the ladder lying at an angle of forty-five degrees. The buckets of all dredges should be so shaped that they will hold their maximum capacity at that angle. A favourite complaint from speculators in dredges that are not getting as much gold as they would like, is:—"We were told the dredge would treat one hundred and twenty tons an hour, and we have measured up what she has done and it is not half that." In the first place they have measured up the ground in the solid, quite overlooking the fact the buckets of the dredge break this down and loosen it under water, it therefore occupies considerably more space than when in the solid, that there is a lot of broken stowage in a bucket without one or two big stones in it, and running at the speed dredge buckets run (say twelve buckets a minute) a badly filled bucket will come up occasionally, in spite of the efforts of the winchman, it may be very hard cemented ground, and the dredge has to actually pick every foot of it down with her grabs, and scrape up what she can get with the buckets, or, it may be, a stiff puggy clay appears in the face, which is compressed into the buckets with the full power of the dredge, much the same as a brick machine would squeeze it into a brick mould. Now, having got this clay into the buckets, the next problem is how it is to be got out again in the interval of time lapsing between each bucket, one-twelfth of a minute (that is five seconds, it is really less) and, lastly you probaby find on discussing the matter further with them, that their dredge has struck a bit of shallow gronnd, say six or eight feet deep, and that the ladder is lying at such an angle that it would be a physical impossibility to fill the buckets to more than one third of their capacity.

The discussion generally terminates, as most of that class of discussions do, by the speculators concluding that the "dredge" is a failure. The engineers assured them she would treat one hundred and twenty tons an hour and she dosen't, and that's all they know about it.

A good deal of judgment on the part of the dredge master is required in regard to the amount advisable to lift. At times when in very rich wash of a clayey nature, it has a better chance of treatment in the screen and on the tables if passed through in smaller quantities. If, on the other hand, it is poor and of a loose gravelly nature, to make working expenses it might be necessary to push the dredge to her utmost capacity. Dredge masters, as a rule, when they get on to a rich lead or patch reduce the quantity lifted, if the dredge is running full buckets to give it a better chance of being more thoroughly washed in the gold saving appliances.

The motive power of a "Paddock" dredge is either steam, electricity, or water. Where water is used, as at Waipori, in New Zealand, Pelton wheels or some form of turbine are the generators of of the required motion. Oil engines have been suggested where fuel has to be carried long distances at a heavy rate of freight; but I am not aware of any plants at present using oil engines. Whatever motive power is used, it must be capable of being governed under all varying conditions. of load.

Dredge engines should be made with moveable eccentrics to enable them to be reversed in a few minutes, but I will draw attention to this later on under the tumblers.

Approximately about sixty per cent. of the power of the dredge is absorbed by the centrifugal pump in lifting the water for treating the wash.

The size of the engine varies with the capacity, dredging depth and water supply required for tables.

The type of engine adopted by most designers is the high pressure compound horizontal. The condenser is a surface one and of a pattern used only on dredges. The water used for washing the gold is utilised prior to going on the tables as the steam condensing medium; the condenser really forming part of the discharge pipe from the centrifugal pump to the tables or sluice box. The air and feed pumps are independent of the engine itself and are actuated by an eccentric on the first motion shaft, and this system answers very well. Engines of the marine, semi-portable, portable, undertype, rotary, etc., both high pressure as well as compound have been used for the purpose with varying success.

A sluice-box dredge, that is, one without a screen or elevator, takes about the same power to drive, owing to dredges of this class requiring more water for treating the spoil than dredges with screens and tables, and also on account of the extra height it is generally necessary to lift the water and spoil to secure sufficient fall for the sluice-box, which ought to be carried well astern, and its extreme end should be high enough to be well clear of the tailings at the highest possible stacking height of the ground to be dredged.

The boiler is generally given an excess of power, that is, for example, a 16 H.P. nominal engine is provided with a 20 H.P. nominal boiler. The horse-power in excess is given for the purpose of driving the steam winch which utilises from 4 to 8 H.P. nominal, but as it is used intermittently and not continuously the excess boiler power, if not utilised by the steam winch, is advantageous in enabling a full head of steam to be kept without difficulty for the main engine with indifferent firing (or indifferent fuel). In the past stoppages for steam, or rather the want of it, were quite a frequent occurrence.

A number of dredges have independent steam driven electric lighting plants, and these absorb from 1 to 2 H.P.

Marine portable, under-fired tubular, semi-tubular locomotive, loco-tubular boilers, etc., are used for the purpose. The loco-tubular is a favourite both here and in New Zealand, and possesses a number of excellent features for dredge work, so much so that the type is now known by the distinct name of "Dredger" boiler by the English makers.

Wood is the fuel used entirely for firing purposes in Australia

The boiler on a dredge demands and should receive more attention than any other part of the dredge's machinery, but unfortunately gets as a rule less.

With the dirty feed water used, charged with all forms of vegetable and organic matter and mud, together with the lavish and totally unnecessary use of internal lubricants of questionable quality in the cylinders and valves of the engine itself, the risks run are very great indeed. The boiler inspection, under the Dredging Regulations of this State, is practically no inspection at all. In New Zealand all boilers are subjected to a very critical examination every six months by a Government Inspector, and a certificate given if everything is satisfactory. In this State each engineer examines his own boiler and gives his own certificate, which is obviously always satisfactory. The writer ventures to predict a "horrible sensation" on a gold dredge somewhere before very long, in which the boiler will play the "star" part. The hands on gold dredges generally do not know too much about a boiler and its possibilities, and perhaps it is as well for their own comfort that they have not been too lavishly endowed with information on this subject.

In the older type of dredges in New Zealand, as is the custom on harbour dredges, the power generated by the engine was transmitted from the engine to the top tumbler by means of shafting. In gold dredging practice this was found to be too rigid, and the continual jumps and jars of the buckets as they struck boulders, timber, or other hard obstacles in their work was very severe on the gearing and the engine itself, notwithstanding the interposed friction brake. With the object in view of softening or cushioning the shocks on the gearing and engine, the shaft between the crank shaft of the engine and the gearing was done away with; the pinion on the crank shaft of the engine was removed and a pulley substituted, more intermediate gearing was introduced, and the bevel-gearing replaced by spur-gearing; and a pulley, keyed on to the first motion shaft connected by a belt or by ropes to the pulley on the crank shaft of the engine.

This new arrangement eased matters considerably, and now practically all gold dredges are either belt or rope driven, the direct-driven type having disappeared, with the exception of a few old relics that exist in remote parts of New Zealand, more as historical objects than anything else. Bevel-gear has also gone down with its chum, the direct drive, and spur-gear has taken its place, and it in its turn, is now giving way to the helical gear.

Bevel-gear is still greatly used in harbour dredges and almost invariably the direct-drive. But in this class of dredge the working conditions are more even than in the gold dredge.

A popular misconception exists amongst a certain class of those interested in dredges as to what occurs when a dredge or rather the buckets come in contact with a hard obstacle. The impression is that something, meaning some vital portion of the machinery, must go, and in this theory see the solution of the whole problem of breakages and delays and the salvation of the industry. All that is required, so they aver, is to introduce some form of controlling or disengaging apparatus to act when the buckets strike something so hard that they are brought suddenly to a standstill (much in the same style as the barbarians of modern civilisation stop a railway waggon by spragging it, that is, throwing a short stiff piece of timber through the arms of one of the wheels while it is in motion). But I may state that every dredge in existence, whether harbour or gold, has an appliance for this purpose known, in dredging parlance, as the friction. This is so adjusted that when any undue strain comes upon the gearing it slips and stops the top tumbler from revolving until the strain is relieved, either by the winchman manipulating the ladder or the dredge herself. Directly the strain is relieved the top tumbler starts to revolve automatically. This friction apparatus can be controlled by the winchman without moving from his position at the winch, and the buckets stopped at any desired point on the ladder almost instantaneously.

The winch of a dredge occupies the same relative position to a dredge as the slide-rest does to a lathe. Assuming the buckets to be the tool, and in reality they are, the winch feeds the buckets, up or down, forwards or sideways, at the will of the winchman, who manipulates this complicated piece of mechanism. Too much importance cannot be attached to having an efficient winch: however perfect the rest of the design may be, a defective winch neutralizes all its good points. Strength and quickness in manipulation are the main desiderata in its design.

In an ordinary 4½ ft. bucket dredge with, say, a dredging depth of thirty five to forty feet, the winch must be capable of lifting with reasonable speed and ease from thirty to forty tons. This should convey some idea of what is expected from a dredge winch.

In harbor dredges a number of single winches are used, that is, each line has an independent winch, or the lines are grouped on two or three separate winches; say, for instance, the forward lines on one winch, the after lines on another, and the ladder and head lines on another. The single winch for each line necessarily requires several extra men to manipulate them, and as harbor dredges are generally run by governments, harbor trusts, or large public bodies who have plenty of money to spend, the cost of labor is not a serious consideration.

The crew of a gold dredge lifting two hundred and sixty tons per hour is two men per shift. The crew of a harbor dredge doing the same work is twelve men per shift, namely, engineer in charge, mate, fireman, four seamen, two deck hands, two punthands and a carpenter. The larger dredges carry in addition a blacksmith and a boiler-maker, and have a complete plant for effecting their own repairs on board, including a lathe, steam hammer, etc.

On a gold dredge the general practice is to have all lines, namely, head, ladder, port bow-line, port stern or quarter line, starboard bow-line, and starboard stern or quarter line, all on the one winch. Some of the big Molyneux dredges have an independent winch for a preventer line, which is a duplicate head-line to guard against accident. The preventer-line and head-lines being lines that are very seldom used compared with the side-lines and ladder-line, which are almost continuously on the move.

In the original gold dredges, chains were used for mooring purposes, and a number of common crab winches were utilized, generally one for each line (six winches). These crab-winches were manipulated by hand, so the winchman had a good deal of walking about. The next progressive step was the assembling of the six lines on a single winch, which at that time was merely a group of capstans or surging drums, round each of which the respective chains took several turns and fell into a chain locker below deck. The handling of these chains was most laborious work, and in a current like the Molyneux in New Zealand it can be better imagined than described, if the powers of imagination are vivid enough. Harbor dredges still use chains universally, but gold dredges have discarded them entirely and steel ropes have taken their place.

In some dredges the winch is driven by means of belts, ropes, or intermediate gear off the main gearing, but this method is not without its disadvantages and is only adopted in plants where the first cost is the main consideration. It necessitates the running of practically the whole machinery of the dredge to simply operate the winch when found necessary to pull the dredge to anywhere when the main machinery is at a stand-still, say running out or in a line, heaving up a log out of the face, etc.

The modern winch is a complex piece of mechanism, driven by an independent steam engine, or in electric dredges by an independent motor, on which the whole of the six lines can be manipulated with ease by the winchman without moving from his position.

The gearing of a gold dredge, needless to say, must be of the heaviest order, and the greatest care should be exercised in its design and the materials used in its construction. All pinions should be preferably made of cast steel, and cast steel should enter largely into the construction of a dredge generally. Accidents through light or defective gearing are a very common source of delays. Too much stress cannot be laid on the necessity of taking the greatest care of this very important element in the dredge's structure.

The buckets and their accessories, namely, grabs, links and pins, are all the product of the forge or boiler shops, very little cast work of any description enters into their construction in gold dredges. In harbor dredges cast steel buckets and links are in common use, but so far gold dredges have not adopted them.

Manganese steel is the material in general use in bucket pins, but there are other brands of steel equally suitable for the purpose.

In this State very much heavier pins are used than in New Zealand, practically owing to the heavier nature of the ground, and for the same reason the lips and bodies of the buckets as well as the main links are very much heavier.

Spring steel is the material used for bucket lips, and at one time these used to be hardened by tempering; this practice is, however, abolished. The life of a heavy bucket lip in Australia is from four in hard ground to eight months in easy ground. A great deal depends on the way a dredge is handled, and in the lifetimes mentioned it is assumed that they get fair usage and are not made to perform similar duties to a "stone-crusher," "quartz-stamper," or "forest-devil."

There is a great deal more in the design of a bucket than at first meets the eye, and each designer has some particular curve or set in the development of his bucket for which he claims some distinct advantage. There is no doubt that there is a great deal in this very important element of the structure, and as I before compared the winch to the slide-rest of a lathe, we might here extend the comparison and call the bucket the cutting tool, and every engineer knows the importance of the shape of the cutting tool. Every turner has his own particular little twist, lip, or clearance in the same manner as the dredge designer humors his little fancies with the bucket. The whole idea in the design of the turning lathe is to give the cutting tool the best possible chance to do its work; the whole design of a gold dredge (with perhaps the exception of the gold saving and tailings stacking appliances) is to give the bucket the best possible chance of doing its work.

A broken bucket pin is the commonest of all accidents; it averages on the aggregate in this State about two a week. The writer knows of a dredge in Victoria that ran for more than six months without breaking a pin, but this is a record performance. The time occupied in stopping the dredge and putting in a new pin is under half an hour. One of the most aggravating accidents that can happen on a dredge is the snapping of two opposite pins, this generally results in all the buckets and links *i.e.*, the bucket belt, as it is commonly called) dropping into the bottom of the paddock or the river, if a river dredge. Fortune might smile upon you to the extent of permitting one end to remain on board, then with a smart crew and a reversible engine it is only about two or rhree hours work to get them coupled up again, but if you are not so favored, then it is a fishing job in the muddy water of the paddock or river, and you always seem to get hold of the wrong bucket, or wrong end first, and have to overhaul the lot or a large number of them. If the accident happens in say thirty feet of water the belt, in dropping, forms itself automatically into loops and almost knots, and the excessive weight of the falling mass jams and interlocks buckets, links and pins into an almost hopeless tangle. It sometimes happens in grappling that the bite, or a portion of the end of the belt is drawn through a loop in another portion, actually forming a knot. In an ordinary 4½ ft. bucket dredge with a dredging depth of 35 ft., there are thirty-six sets of buckets, links and pins, each set weighing over eight hundred-weight, or a total weight of fourteen and a half tons to drag up without any allowance for spoil that may be in the buckets themselves. With a smile or two from fortune, a good crew and suitable tackle, you might get the bett on again in twenty-four hours; but if the belt is badly tangled up it may mean several days. The Molyneux is a bad place to lose the bucket-belt in.

When the winchman notices that the belt has snapped he should stop the main engine instantly, if possible, but under no circumstances whatever should he pull out the friction, for in so doing he throws away the only possible hope he has of holding on to the end of the belt and checking it from going over the top-tumbler. In releasing the main friction he practically converts the top tumbler into a loose roller for the belt to run off on. Many a belt accident would have been averted had the winchman acted as advised here. A bucket-belt almost invariably goes on the ascending portion, so that besides being heard—for it gives a loud report—it is always within the view of the winchman. This type of accident fortunately is not a common one.

Bessemer steel of boiler quality is the material used for the bodies of the buckets and generally tire steel for the main links. Old railway rolling stock tires make excellent links.

The running speed of buckets varies from ten to fourteen buckets per minute.

The ladder, in its early stages, was constructed of wood, but wooden ladders are a thing of the past. The modern ladder is simply a very strong steel girder suspended or pivoted at one end, and free to move up and down at the other as required and is designed on very nearly identical lines. On the top side of the ladder are a number of rollers extending almost the full width of the ladder, and on these rollers the bucket-belt travels. The types of ladders used vary from the elementary channel-bar pattern, which consists of two parallel channel-bars of a deep section, with distance pieces between to retain them at the width desired for the ladder, to the elaborate braced plate-girder and box-girder patterns.

The lower end of the ladder forms a jaw which is fitted with bearings on each side. The bottom tumbler fits into the jaw and revolves, either on a stationery shaft, or is keyed to a shaft which revolves in bearings provided on either side of the jaw for it. A ladder must be an exceedingly strong and carefully designed structure.

The snapping of a ladder is not an unknown accident by any means, and when it does go, it is generally about two-thirds of the way down. Ladders also have a weakness for twisting, that must be allowed for in the design. A twisted ladder gives a lot of trouble.

To be continued.

Granby Consolidated Mining and Smelting Company.—Mr. Jay P. Graves in a recent interview says:—"With the development work accomplished and the plant in place and in transit, the Granby mines at Phœnix are capable of producing 5000 tons of ore per diem for shipment to the company's reduction works at Grand Forks. We are unable, of course, to treat anything like this tonnage with the present smelting plant, but our plans are to inaugurate a program of extensive additions that will increase the capacity of the works, and eventually bring it up to the same standard that has been reached at the mines. An appropriation of approximately $250,000 will be required to accomplish this end, and considerable time will be required to work out all the plans in contemplation. We will undoubtedly make a start at a comparatively early date, however, and keep at the proposition until the end in view is attained."

Mica Production in the United States.

In the advance sheets of that excellent publication of Dr. David T. Day's, "The Mineral Resources of the United States," published by the United States Government, some very interesting figures are given of production of mica across the border. From this article it would appear that the total plate mica produced in the United States during the year 1901 was 360,000 pounds, valued at $98,859 as compared with 456,283 pounds, valued at $92,758, in 1900. During the past two years there has been a large increase in the amount of mica produced, with, however, but a slight increase in value, a condition which is undoubtedly due to the very large amount of small-sized mica disc and rectangular sheets that have been cut for electrical purposes, and that has in former years been used as scrap mica. Some of this plate mica has been obtained from old mica dumps. There was a large falling off in the amount of scrap mica produced in 1901, which has been estimated as 2,171 short tons, valued at $19,719, as compared with 5,497 tons, valued at $55,502, in 1900. This falling off in the production of scrap mica is undoubtedly due to the exhaustion of the large piles of scrap that had accumulated during the last quarter of a century, when there was a market only for plate mica.

The relatively small production of mica can be accounted for by the low prices maintained for plate mica, by the uncertainty of the occurrence of the mica in the veins, and by the large number of small producers who are entirely dependent upon one small mine, and who, when the mica in this begins to give out or is poor, have not the means to carry on much dead work, and have no other deposit to help fill out this deficiency. The consolidation of a number of the mica mines in different sections might be profitable. The importation of mica from Canada and India at a low valuation tends also to curtail the production of mica in the United States. This is especially true of the mica imported from India, which can be mined and landed in this country at a lower price than, in some cases, it can be mined in the United States.

The production of mica during 1900 and 1901, by States, is given in the following tables:

Production of mica in 1900, by States.

State.	Sheet mica.	Scrap mica.
	Pounds.	Short tons.
New Hampshire	191,118	645
North Carolina	107,255	4,450
South Dakota	*a* 123,090	80
New Mexico	9,620	258
Virginia	16,000	....
Other States *b*	9,200	64
Total	456,283	5,497

a Sold in rough or unmanufactured condition *b* Idaho, Maine, Nevada and Rhode Island.

Production of mica in 1901, by States.

State.	Sheet mica.	Scrap mica.
	Pounds.	Short tons
New Hampshire	65,800	250
New Mexico	3,100	146
North Carolina	266,160	1,775
South Dakota	25,000	....
Total	360,060	2,171

As is seen from the above tables, Idaho, Maine, Nevada, Rhode Island, and Virginia, which were producers of mica in 1900, had no production during 1901, and there was a very noticeable falling off in the production of the other States, with the exception of North Carolina. In North Carolina there was a decided increase in the production of plate mica, but a large falling off in the production of scrap mica.

COMPANY NOTES.

Canadian-American Coal and Coke Co.—At this company's colliery at Frank Alta., work is proceeding briskly and the output for November has been the best since the colliery was opened. The main entry, which is being driven ahead as fast as possible, is now in on the coal seam a distance of over one mile and has reached a vertical depth on the vein of over 1,000 feet. The quality of the coal has much improved with depth and that being taken out in the main entry and deeper workings is of a very superior quality. The lower entry is also being driven ahead and is now in some 1 600 feet. With two air shafts through to the surface and the big fan driving 22,000 cubic feet of air into the workings, the Frank coal mine is one of the best ventilated properties in the Dominion. Over 150 men are now employed by the company, and as soon as more cars are available and the loading facilities improved there will be work for twice that number of men.

Bosun Mines Limited.—Head office reports 60 tons galena and 100 tons zinc shipped during the month of October.

Hall Mining and Smelting Co.—The report of the directors of the Hall Mining and Smelting Company, Limited, for the year ended June 30, 1902, which will be presented to the shareholders at the third ordinary general meeting on the 23rd inst., states that in consequence of the exhaustion of the ore reserves, and the necessity therefore for writing off the amount of £19,751, charged to development account at June 30, 1901, and also writing off £1 094 from the value of the mine supplies, there is a loss on the mining account of £6 980; on the other hand, the smelting account shows a profit of £5,071. After taking credit for sundry receipts, £1,735, and providing for the general expenses, including debenture interest and the balance of preliminary expenses not dealt with last year (together £5,772), there is a loss of £5,945 which, together with £6,673 written off for depreciation, must be added to the amount brought forward from last year—viz. £6,980—making a total debit balance to be carried forward of £19 599. It was not until the spring of the year that the permanence of the ore body at the lower levels became doubtful. Before deciding to abandon operations, the board subsequently had the mine examined by the best expert available, whose views entirely coincided with those of the other two. The board have leased the mine to Mr. M. S. Davys, formerly superintendent, on satisfactory terms, one of the conditions being that they can resume possession, should they wish to do so, whenever the output reaches 50 tons a day. The advantage of this arrangement is that the mine will be thoroughly explored by one who knows the property well and has faith in his ability to find other ore bodies entirely free of expense to the company. Smelting.—The most serious obstacle to the expansion of this branch of the company's business has again been the loss caused by the fall in the prices of metals. Some further extension of the time for final settlement of purchase is necessary, and steps to that end will be taken as soon as possible. Notwithstanding the difficulties which have had to be met, the business still shows a profit and there is every reason to expect reasonable profits in the future, more especially owing to the cheapening of flux and to the reduction of working expenses through the installation of the elecric plant. As soon as a refinery is erected in the immediate vicinity there will be a considerable saving in the freight which now has to be paid for sending the bullion to a distant refinery in the States. Recognizing the desirability of reducing the management expenses, the board have decided to reduce their number to three.

Ymir Gold Mine, Limited.—An extraordinary meeting of the Ymir Gold Mines, Ltd., is called for 29th inst., to consider a reconstruction scheme in terms of the following circular, which has just been issued:—It will be remembered, the directors observe, that at the annual meeting held on 6th May last, a resolution was passed sanctioning an increase in the capital for the purpose of providing funds to pay for the installation of the cyanide plant, and for the further development of the mine. On reference to the circular of 15th August last, which enclosed Mr. Hooper's report upon the mine, it will be seen that at the extreme eastern end of the tunnel at the 1,000 ft. level, where the work was suspended, the values were found to be higher than at any other part of the vein at this level. From this fact, and from the general tenor of Mr. Hooper's report, the directors have great confidence that as further development is accomplished the mine will prove to be as valuable as was ever expected. To enable this development to be systematically carried out, it is necessary to provide additional funds. Under present market conditions, it is obviously impossible, they add, to increase the capital. In order to pay off the company's liabilities for the cyanide plant (which is now in satisfactory operation), liquidate the bank loan and make provision for the requisite additional working capital, the directors recommend that the company be reconstructed on the basis of an assessment of 3s. per share on the issued capital of £200,000, payable as to 6d. per share on the application, and 1s. per share on allotment, and the balance in calls of 6d. per share at intervals of not less than one month. The effect of this arrangement will be, they say, to free the company from all its liabilities, and leave it with ample working capital for further development work. It will be remembered, they conclude, that during the four years the company has been in operation it has made profits sufficient to invest £46,000 in permanent works and development, and has also distributed £60,000 in dividends. The work of connecting the No. 10 tunnel with the upper workings by means of an upraise (which is now in progress) is necessary for the economical development of the mine. Until this is completed it is only possible to keep 50 stamps at work.

Chippewa Consolidated Gold Mining Co.—This company operating the Wendigo gold mine, Lake of the Woods, has been overhauling the old plant and getting the mine in shape for the resumption of mining. Under capable management this property should do well.

Camp Bird.—The secretary states:—"The following cable has been received from the mine manager, reporting for the month of September:—The mill ran 29 days and crushed 5,450 tons of dry ore. Bullion sales (including cyanide bullion, estimated at $9,000). $112,500; concentrates (340 tons), $32,000—$144,500. Working expenses and developments, $53,150, leaving the profit of the mine at $91,350, equal to, say, £18,800. From this should be deducted the monthly expenses in London (including consulting engineer's fee) of about £700, leaving a profit for the month estimated at £18,100. There has been expended on construction account since the property was taken over to 30th September, $29,705, say, £6,112."

Velvet Rossland.—The manager cables the following returns from smelter:—"180 tons yielded 184 ozs. gold, 156 ozs. silver, 24,363 lbs. copper. Net proceeds from smelter $4,078, or an average of £4 10s. per ton net."

Hastings (B.C.) Exploration Co.—At the meeting of this company held in London during the early part of the present year, the directors gave a very gloomy report on the Arlington mine at Erie which is one of the principal assets of the company. They informed the shareholders that according to the latest expert advice the mine appeared to have been gutted and all the pay ore practically worked out. Since then, however, it is reported that new bodies of ore have been discovered and come under treatment, which will give a new life to the property. The total shipments of ore concentrates during the past summer are as follows:—

May	65.5	$2,488
June	119	4,610
July	122	4,171
August	120	3,721
September	122	4,604
Total	548.5	$19,594

Showing a net average value of over $35 per ton.

Montreal & Boston Copper Company.—The company's operations have been running very smoothly since September 17. The company is building a brick engine and blower room, 120 ft. by 38 ft., installing 2 new 125-h.p. high-pressure boilers, a No. 7 Connorsville blower, direct connected to an engine, another furnace 176 by 40 in., and expects all this equipment to be running by January 1. Manager Goodell expects to place an order for a third furnace soon, and have 3 furnaces in blast by March 1. The company's ore supply is pronounced ample. The matte is contracted to the Granby Mining and Smelting Company.

Le Roi Mining Co.—Mr. Mackenzie's report covering the operations of the company for September shows that the profits from the ore shipped, though not as high as in previous months, were satisfactory. The tonnage shipped during the month, together with its contents and gross value, was as follows:—

Dry tons—First class, 13,667; second class dump, 1,999; total, 15,666.

Ozs. Au.—First class, 6,778; second class dump, 660; total, 7,438.

Ozs. Ag.—First class, 12,145; second class dump, 933; total, 13,078.

Pounds Cu., wet—First class, 580,005; second class dump, 50,722; total, 630,727.

Value per ton—First class, $15.26, second class dump, $9 76.

The cost of breaking and delivering the first class ore on the railroad cars was $2.65 per ton, while the cost of development was equal to $1.25 per ton—increases of 25c. and 51c. per ton respectively as compared with August. The explanation for the relatively higher expenditure is found in the facts that the tonnage stoped during September was smaller and the exploration work greater than was the case in the previous month.

Mine Expenditure.—The expenditure for the month on mine account was $54,054.

Northport Smelter.—The expenditure for the month was $157,843. The public ores purchased during the month amounted to 5,740 tons, containing 2,953 ounces of gold, 6,080 ounces of silver, 282,825 pounds of copper. The tonnage treated during the month was 23,681 wet tons, segregated as follows:

Roasted ores	15,234
Raw ores, Le Roi	198
Raw ores, Le Roi second class	2,537
Raw ores, public	5,712

Estimated Profit for Month.

The gross value of the first class ore shipped from the mine was $15.26 per ton, equal to	$208,558
From this deduct smelter losses, refiners' settlement rates and interest on gold and silver values for 90 days and copper 60 days, at 6 per cent. equal to $2.61 per ton	35,671
	$172,887
Deduct cost of mining and smelting at $8.18 per ton	111,796
Net estimated profit on first class ore	$61,091
The gross value of the second class dump ore shipped from the mine was $9.76. equal to	$19,519
From this deduct smelter losses, refiners' settlement rates and interest on gold and silver values for 90 days and copper 60 days, at 6 per cent., equal to $1.56 per ton	3,118
	$16,391
Deduct cost of loading and smelting, at $4.44	8,875
Net estimated profit on second class ore	$7,516

The total estimated profit as above amounts to $68,607.51, being greater by nearly $6,000 than estimated in the cabled returns of the 6th inst., owing to the fact that the smelting costs proved to be lower than anticipated.

Le Roi No. 2.—Under date Rossland, 9th November, the company's manager telegraphs as follows:—"Shipments last month amounted to 2,413 tons; contents, 1,042 ozs. of gold, 3 360 ozs. of silver, 66 tons copper. The returns from ore amount to $19,390. Having located with diamond drill on 300 ft. level to the west of tramway dyke upward continuation of ore body. Over footwall stope above 500 ft. level diamond drill core shows the ore is 10 ft. thick; average of three assays is—gold $96 per ton, copper 2½ per cent. Will probably require to crosscut to the south 95 ft. to open shoot; have started to crosscut for ore body." [September: 6,070 tons, value $86,351.]

Centre Star Mining Co.—The annual meeting of the Centre Star Mining Company was held on the 27th, and the various reports presented. The financial statement shows that the indebtedness of the company had been reduced to $160.028 two months ago, and was being reduced at the rate of $30,000 a month, which would make it about $100,000 now. During the year $29,836 has been written off for the depreciation. The assets include $3,300,540, the value of the Centre Star mine; $1,480 cash in bank; $220,938, machinery and buildings; $16,250 in stocks of other companies; and $10,629 accounts receivable. Mining and development have cost $172,552, and diamond drill prospecting $8 371. Manager Kirby, in his report, said:—"The condition of the Centre Star mine has been improved during the year. The reserves of pay ore have been incresed, and the heavy decline in copper has been more than offset by the reduction in smelting rates, and the satisfactory solution of the problem of treating the low grades by milling, now makes it certain that large bodies of the ore exposed will soon be available. Ore sales during the year were 11,987 tons, averaging $13.31, smelters' gross assay value. The development of the mine has from the beginning continued to expose large quantities of ore too low in grade for smelting, but rich enough to promise a handsome profit to successful milling, and now that the difficulties of such treatment have been overcome, these low grade masses will soon be available." The net proceeds from ore sales were $89,752. The directors were re-elected.

Mikado Gold Mining Co.—The following is extracted from the proceedings of the last annual meeting of this company held this month in London:—The Secretary (Mr. C. F. MacNicol) having read the notice and the auditor's certificate, the Chairman said: The accounts are full and exhaustive, and do not call for any particular remark. The expenditure has been very closely watched, both at the mine and in England, and we feel assured that we have received full value for our money. Unfortunately, it has not been possible to show a profit. Mining is proverbially uncertain, and it seems that the Mikado has been particularly unlucky. It started with rich ore, in what appeared to be a permanent shute, and this continued to a depth of 240 ft. in No. 1 lode. No. 2 lode did not yield so well, but produced payable quartz, and there seemed every probability that the forecast, on which we raised additional capital, would have been verified. Unfortunately, in both lodes the values steadily decreased, and the further sinking and driving on No. 1 lode showed that the shute of ore became very much shorter and poorer, so that on reaching the 10th level, at a depth of 600 ft. from surface, it had so dwindled away in extent and value as to make it unadvisable to continue further sinking. Similarly, at No. 2 lode, the ore cut out at a depth of 300 ft. Such being the disappointing condition of affairs, it was resolved to continue the driving of No. 9 level at a depth of 540 ft., to search for another run of ore, and also to intersect the cross-lode No. 3, known to exist at a distance on surface at about 1,200 ft. south of the main shaft, it being probable that at the junction of these lodes an improvement in value would take place. Accordingly, during the greater part of 1901, and up to the present date, this No. 9 level has been pushed forward, and it is now thought that it should be within a short distance of the intersection with No. 3 lode. In the meantime, ore of low grade was raised from the old workings and milled, which has helped to pay the mine expenses; but latterly the supply has fallen off both in quantity and quality. It was therefore decided to shut down the mill and proceed only with development. I now come to an encouraging feature in our working. In 1898, when the mine was looking well, particularly in its southern section, all the levels were driven in that direction in the extension of the rich shute of ore, and no work was done to the northward of the main shaft, except at No. 4 level, which was driven for about 400 ft. Only a small bunch of payable ore was found; the vein dwindled down to 6 in. of barren quartz, so no further work was done.

During the winter of 1897-98 it was resolved to take advantage of the frozen state of the lake and to put down a diamond drill hole, to test the position and value of the lode under the lake. This was done at a distance of about 1,400 ft. from the main shaft, the lode being cut at a vertical depth of 176 ft. Taking the distance on the incline of the boring, small strings of quartz carrying small values were met with at 170 ft. and 179 ft. A large rib was found between 207 ft and 216 ft., assaying $2.50, and another, apparently the footwall of the lode, between 230 ft. and 237 ft.; this gave a value of $17 per ton. The continuity of the lode was thus proved. This and its value were further tested by a Toronto company, who bored on an island about half a mile from our northern boundary, and there met with the lode, said to assay $20. This boring disclosed the important fact that the lode was in granite formation. Hitherto our workings to the southward had been along the contact of the granite and trap, sometimes piercing a considerable length of the former, where the best ore was always found, the quartz being pinched and poor in the trap. We therefore hope that, as the 4th level progresses into the granite zone lying to the northward, so the value will increase. As you will see from the manager's cable, dated October 23, in the report, the lode is widening out, and payable ore has been found. And a cable received yesterday reports that 50 ft. have been driven in No. 4 level, that the lode is 2 ft. wide, and averages $7 per ton, with every prospect that the ore will continue. This is very encouraging. Unfortunately, as you will see from the directors' report, our funds are exhausted, and it is necessary to consider the best means of raising money to continue working. This is having our very careful thought, and several schemes are under consideration. We are taking the advice of several of our largest shareholders, and very shortly the result of the deliberations will be placed before you. Your directors are strongly impressed with the value of our property, and it is impossible to conceive that a mine, which has produced some £80,000 in smelted gold from a very small section, should be played out, seeing that its area is some 300 acres, and that several lodes, not yet explored, are known to exist within our boundaries.

The board therefore believe, with the information already gained, it would be judicious, in the interest of all concerned, that more money should be found to prosecute further work. As I have already said, our funds are exhausted. We are in debt to the extent of between £2,000 and £3,000, which, together with the amount necessary to carry out the economical policy suggested by the manager in his latest communication, makes it obligatory to raise at least £5,000. This may be done by the issue of the £12,500 reserve capital; but as it may not be possible to get shareholders to take this up at par, the only alternative short of reconstruction would be the issue of a small amount of debentures on the security of the property and assets of the company. The directors would be glad of any suggestion from shareholders now present before putting any scheme before them for raising the necessary funds. Shareholders may feel assured that any money will be expended by our manager to the best advantage when I tell you that for many months the entire charges at the mine worked out at the very low rate of $3½ per ton of ore treated. This included mining, milling, cyaniding, development and management. I do not think that there is any mine in Canada or the United States worked by steam which will show such excellent working costs. This is due to the very careful and complete accounts kept by our manager, whereby every item of expenditure can be checked and compared; so that any undue cost under any particular head of account can be at once detected and rectified I beg now to move the resolution: "That the report of the directors and statement of accounts be received and adopted."

Nova Scotia & Baltimore Mining Company.—The work in Cariboo District, on the Lake lode, is of great importance to the district and to the gold mining interests of the Province. For a number of years mining has been done to a depth of 300 and 400 ft., the one at this depth being low grade. The company having erected a modern 40-stamp mill and adequate appliances to sink deeper, determined to sink to 1,000 ft. At 700 feet, much better ore has been struck, and from a level driven at this point 350 tons of ore yielded 1.6 oz. to the ton. The lode is from 4 ft. to 8 ft. thick.

Canadian Smelting Works.—The report is current that the refining process in practice at the Trail smelter for some months past has given such satisfaction as to justify the Canadian Smelting Works in branching out somewhat extensively in the refining business. The process is an electrolitic system, and the Trail refinery has been turning out about ten tons of refined lead for six months or thereabouts. Their new plant will be on a considerably enhanced scale, although no details have been divulged on this point as yet. The company is said to be hesitating between sites at Nelson, B.C., and a point on tide-water, with the chances in favor of their choosing the inland point. Being closely identified with the Canadian Pacific system it is not so essential that the refinery should be constructed at tidewater as would be the case with a strictly independent plant. The important feature of the matter is that the company has concluded that there is a future for lead refining in Canada, and it is somewhat significant also, inasmuch as a corporation so closely identified with the great railroad lobby would scarcely venture a large investment in refining works had it not an assurance that the forthcoming session of the House of Commons would witness such measures of protection as will substantially assist the Canadian lead industry.

ADVERTISING PAYS.

Montreal, 21st February, 1902.

The Canadian Mining Review,
Ottawa.

We have been advertising in the Canadian Mining Review for some sixteen years, and as extensive manufacturers of mining machinery in Canada we have great pleasure in stating that we consider that the money spent in reaching the public through your columns has paid us an hundred fold. We consider it, without exception, the best medium to reach the mining, engineering and investing public in the Dominion of Canada, not taking into consideration its foreign circulation. Our continued patronage will serve as substantiating the above assertions.

We are

Yours faithfully,

THE JAMES COOPER MFG. CO.

DOMINION OF CANADA

SYNOPSIS OF REGULATIONS

For Disposal of Minerals on Dominion Lands in Manitoba, the North-West Territories, and the Yukon Territory.

COAL.

Coal lands may be purchased at $10.00 per acre for soft coal, and $20.00 for anthracite. Not morè than 320 acres can be acquired by one individual or company. Royalty at such rate as may from time to time be specifled by Order-in-Council shall be collected on the gross output.

QUARTZ.

Persons of eighteen years and over and joint stock companies holding Free Miner's certificates may obtain entry for a mining location.

A Free Miner's Certificate is granted for one or more years, not exceeding five, upon payment in advance of $10.00 per anaum for an individual, and from $50.00 to $100.00 per annum for a company, according to capital.

A Free Miner having discovered mineral in place may locate a claim 1500 x 1500 feet by marking out the same with two legal posts, bearing location notices, one at each end of the line of the lode or vein.

The claim shall be recorded within fifteen days if located within ten miles of a Mining Recorder's Office, one additional day allowed for every additional ten miles or fraction. The fee for recording a claim is $5.00.

At least $100.00 must be expended on the claim each year or paid to the Mining Recorder in lieu thereof. When $500.00 has been expended or paid the locator may, upon having a survey made and upon complying with other requirements, purchase the land at $1.00 per acre.

Permission may be granted by the Minister of the Interior to locate claims containing iron and mica, also copper in the Yukon Te ritory, of an area not exceeding 160 acres.

The patent for a mining location shall provide for the payment of royalty on the sales not exceeding five per cent.

PLACER MINING, MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

Placer mining claims generally are 100 feet square; entry fee, $5.00, renewable yearly. On the North Saskatchewan River claims are either bar or bench, the former being 100 feet long and extending between high and low water mark. The latter includes bar diggings, but extends back to the base of the hill or bank, but not exceeding 1,000 feet. Where steam power is used, claims 200 feet wide may be obtained.

DREDGING IN THE RIVERS OF MANITOBA AND THE N.W.T., EXCEPTING THE YUKON TERRITORY.

A Free Miner may obtain only two leases of five miles each for a term ot wenty years, renewable in the discretion of the Minister of the Interior.

The lessee's right is confined to the submerged bed or bars of the river below low water mark, and subject to the rights of all persons who have, or who may receive entries for bar diggings or bench claims, except on the Saskatchewan River, where the lessee may dredge to high water mark on each alternate leasehold.

The lessee shall have a dredge in operation within one season from the date of the lease for each five miles, but where a person or company has obtained more than one lease one dredge for each fifteen miles or fraction is sufficient. Rental $10.00 per annum for each mile of river leased. Royalty at the rate of two and a half per cent., collected on the output after it exceeds $10,000.00.

DREDGING IN THE YUKON TERRITORY.

Six leases of five miles each may be granted to a free m'ner for a term of twenty years, also renewable.

The lessee's right is confined to the submerged bed or bars in the rivers below low water mark, that boundary to be fixed by its position on the 1st day of August in the year of the date of the lease.

The lessee shall have one dredge in operation within two years from the date of the lease, and one dredge for each five miles within six years from such date. Rental, $100.00 per mile for first year, and $10.00 per mile for each subsequent year. Royalty ten per cent on the output in excess of $15,000.00.

PLACER MINING IN THE YUKON TERRITORY.

Creek, Gulch, River, and Hill claims shall not exceed 250 feet in length, measured on the base line or general direction of the creek or gulch, the width being from 1,000 to 2,000 feet. All other Placer claims shall be 250 feet square.

Claims are marked by two legal posts, one at each end bearing notices. Entry must be obtained within ten days if the claim is within ten miles of Mining Recorder's office. One extra day allowed for each additional ten miles or fraction.

The person or company staking a claim must hold a Free Miner's certificate.

The discoverer of a new mine is entitled to a claim 1,000 feet in length, and if the party consists of two, 1,500 feet altogether, on the output of which no royalty shall be charged, the rest of the party ordinary claims only.

Entry fee $15.00. Royalty at the rate of 2½ per cent. on the value of the gold shipped from the Territory to be paid to the Comptroller.

No Free Miner shall receive a grant of more than one mining claim on each separate river, creek, or gulch, but the same miner may hold any number of claims by purchase, and Free Miners may work their claims in partnership, by filing notice and paying fee of $2.00. A claim may be abandoned and another obtained on the same creek, gulch, or river, by giving notice, and paying a fee.

Work must be done on a claim each year to the value of at least $200.00, or in lieu of work payment may be made to the Mining Recorder each year for the first three years of $200.00, and after that $400.00 for each year.

A certificate that work has been done or fee paid must be obtained each year; if not, the claim shall be deemed to be abandoned, and open to occupation and entry by a Free Miner.

The boundaries of a claim may be defined absolutely by having a survey made, and publishing notices in the *Yukon Official Gazette*.

HYDRAULIC MINING, YUKON TERRITORY.

Locations suitable for hydraulic mining, having a frontage of from one to five miles, and a depth of one mile or more, may be leased for twenty years, provided the ground has been prospected by the applicant or his agent; is found to be unsuitable for placer mining; and does not include within its boundaries any mining claims already granted. A rental of $150.00 for each mile of frontage, at the rate of 2½ per cent. on the value of the gold shipped from the Territory. Operations must be commenced within one year from the date of the lease, and not less than $5,000.00 must be expended annually. The lease excludes all base metals, quartz, and coal, and provides for the withdrawal of unoperated land for agricultural or building purposes.

PETROLEUM.

All unappropriated Dominion Lands shall, after the first of July, 1901, be open to prospecting for petroleum. Should the prospector discover oil in paying quantities he may acquire 640 acres of available land, including and surrounding his discovery, at the rate of $1.00 an acre, subject to royalty at such rate as may be specified by Order in Council

OTTAWA, 9th Dec., 1901.

JAMES A. SMART,
Deputy of the Minister of the Interior.