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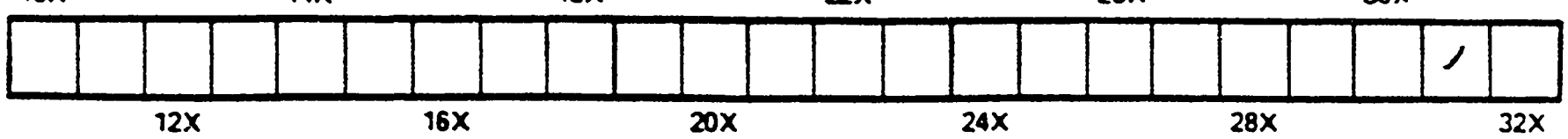

The Canadian Mining Review

Established 1882

Vol. XIV.—No. 11 1895—OTTAWA, NOVEMBER—1895. Vol. XIV.—No. 11.

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MINING LAWS OF ONTARIO.

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

Locations range from 40 to 320 acres.

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

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

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Claims must be worked continuously.

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

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

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

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

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

ARCHIBALD BLUE,
Director Bureau of Mines

TORONTO, May 25th, 1894.

CONDITIONS

OF

Obtaining Government Drill to Explore Mines or Mineral Lands.

Owners or lessees of mines or mineral lands in Ontario may procure the use of a Government Diamond Drill, subject to the provisions of the Rules and Regulations relating thereto, upon giving a bond for payment to the Treasurer of the Province, of costs and charges for (1) freight to location, (2) working expenses of drill, including labor, fuel and water, (3) loss or breakage of bits, core lifters and core shells, (4) wear or loss of diamonds, (5) other repairs of breakages and wear and tear of machinery at a rate per month to be estimated, and (6) an additional charge of $50 per month after the mine or land has been shown, through use of the drill, to be a valuable mineral property.

Of the aggregate of costs and charges above enumerated, excepting the sixth item, forty per cent. will be borne by the Bureau of Mines in 1894, thirty-five per cent. in 1895, thirty per cent. in 1896, and twenty-five per cent. in each year thereafter until the end of 1900. All accounts payable monthly.

For Rules and Regulations *in extenso* governing the use by companies and mine owners of Diamond Drills, or other information referring to their employment, application may be made to ARCHIBALD BLUE, Director of the Bureau of Mines, Toronto.

A. S. HARDY,
Commissioner of Crown Lands.

Toronto, October 17, 1894.

THE MINING REVIEW

Established 1882

Official Organ of The Mining Society of Nova Scotia; The General Mining Association of the Province of Quebec; The Asbestos Club; and the Representative Exponent of the Mineral Industries of Canada.

B. T. A. BELL, Editor. Published Monthly. OFFICES: Slater Building, Ottawa.

VOL. XIV., No 11 NOVEMBER, 1895. VOL. XIV., No. 11

Canada and the Gold Boom.

We all want to be rich, and nature's way of getting rich is for men to work. But hard work is not pleasant, and the whole world is in quest of an easy way of getting rich, a royal road to wealth. Multitudes of men who are not physically adapted to manual labor, or who are constitutionally averse to bodily effort seek to make a living by their wits: by getting possession of something and disposing of it to another for more than it cost. They persuade a person to part with goods at the lowest price he can possibly be induced to accept and their efforts are then devoted to ascertaining what is the highest price that others can be prevailed upon to give. In some cases, instead of buying from individuals they persuade the government to give them great privileges, franchises, charters, grants of land, protection against competitors by special customs duties, and they proceed to make the most of these gifts and favors by extorting the utmost value in return for their disposal or use. Instead of buying property outright, some engage in betting whether prices will rise or fall. They may select any kind of merchandise for which there is a general demand, or they may place their wagers upon shares in chartered companies, and employ brokers to place their bets in the stock exchange. All this is called doing business. Some persons bet upon cards, horse races, elections or other chances of life This is called gambling. There seem to be three classes engaged in making a living. workers, business men and gamblers, though other classes manage to exist—idlers, beggars and thieves. The idlers are the heirs of rich people or else retired capitalists; beggars are those who live on charity, and the thieves are those who take the property of others without consent. These six classes constitute society.

The only class that can be commended from an ethical standpoint is that of the workers, including those who labor with their brains to perform a useful service. But, strange to say, this class is looked down upon by fashionable society and it is only business men, or idlers who live upon past business gains, who are considered respectable. This social endorsement, combined with the greater ease of business life, leads to an avoidance of physical labor by all who have the intellect and opportunity to gain wealth through securing an advance in values. One charm of this method is its frequent rapidity. A fortune may be made in a year, a month, a day, or an hour, if the tide of speculation is taken at the flood; whereas, to gain a competency by labor, involves a lifetime of weary toil, under most disheartening contingencies. No wonder then that multitudes seek the easy, popular, fashionable road to wealth, although they know that many fall by the way and that of the final goal of affluence, it may be said: "Few there be that find it."

The latest exhibition of this effort to grow rich by betting has been given by the investors in gold mining shares in London. This is spoken of as the mining craze, the gold mania; but it is nothing of the sort. People hear that certain shares are rising in value, and they buy, hoping that the rise will continue. Their opinion is not based upon any judgment of merits, but upon the probability of popular favor. The question is not, is it good? but, will it go? These people are not always fools, they are not usually misled by any false or exaggerated statement as to the value of the property. Their only interest is in the fact that the shares are higher today than they were yesterday, and that there is a good chance that they will be higher tomorrow. Hardly any one buys the shares as an investment hoping for a dividend. They simply seek to sell the shares at an advanced price and get out before the reactionary crash comes; and most of them know that it is bound to come.

Many of the companies formed to operate South African mines have been able to get their shares made a means for speculation even before they commenced operations, and to find their value increased many fold, although there was not the slightest prospect of a dividend in the near future. One company, called the East Rand Proprietary Mines, Ltd., is mentioned in the *Investor's Review* as not having enjoyed a sixpence of revenue, and yet having the market value of its shares raised by speculation from $650,000 to £7,000,000.

The *Investor's Review* for November contains an interesting and well-written article entitled "Notes by the Way on the Mining Market Gamble." It describes how the excitement spreads by rumors:—

"Every day in the city, and all day long, the ear catches scraps of the market chitterings like these:—'Jack Bounder is retiring; made a pot of money; hadn't two sixpences to rub together a year ago.' 'To my certain knowledge, Ted Swagger was absolutely gravelled in '93; had to borrow a 'fiver' from Bill Fulloblud to get a new suit of clothes; now the cad drives a phaeton and pair, splendid cobs too; 'tis said he has made £300,000.' 'Guess who I met yesterday?' 'Cant.' 'Why, Tom Sparrowbrain.' 'You don't mean that; what's he doing?' 'Made his pile, he says; bought a nice place down in Berks, keeps a spiffin' turn-out, and spends £5,000 a year at least.' 'Well, I'm blanked; why, he hadn't two shirts when I saw him last.'

Of such are the stray talks of the street, and the words come forth with a touch of admiring envy in them quite beautiful to behold. The speakers seem to be awe-struck as much almost as envious. That it is when the tittle-tattle falls on the South African millionaires that the voice deepens into a tone of reverential worship. 'So-and-so has made five, six, millions, sir, in two years; and has got the money too,' the devotees cry. You feel a kind of creepy sensation in the back as words like these are thrown at you, so profound is the veneration expressed by the utterer. . . . . The average British dunderhead might not comprehend the 'cyanide process,' 'adits,' 'deep levels,' and 'dwts. to the ton,' but he felt he could comprehend a duke, and when the Duke of Abercorn and the Duke of Fife, with a whole troop of the labelled and unlabelled at their heels, attached themselves to the fortunes of the 'Chartered Company,' he became awake to the fact that there must be something in it.' From this conviction to 'buying blind' was but a day's sleep. All must be right when the 'usband of the Prince of Wales' daughter tho't it good enough for 'im,' as grocer Jones and tailor Spratt would remark to each other over their pipes and beer. After this endorsement of rank and fashion, cupidity felt itself ennobled and sanctified. Generals of the army and admirals of the fleet were at equal liberty with the poorest scrag of humanity who served them, to descant at dinner-tables, with the diner-out's know-everythingness, upon the remarkable gold deposits of South Africa."

But it is not only the investors in rising shares who make profits; a horde of promoters, underwriters, advertising agents and publishers reap fortunes. A man comes to London with a mine or a "prospect." He finds a promoter, styled "Financial Agent," to take up the matter. The promoter finds a man who agrees to advance the money for advertising, provided he is repaid three times his outlay in case the company

floats. He buys an influential board of directors by gifts of blocks of shares. He finds underwriters, who, for a commission of from 10 to 25 per cent. guarantee the subscription by the public of a certain amount of shares. Advertising agents, who have valuable lists of investors names, address 100,000 or 1,000,000 prospectuses and receive handsome pay. Newspapers are paid large sums for notices and editorials. Blackmail is levied by obscure "Financial Journals," who threaten attack if not subsidized. To meet all these expenses the price to be paid for the mine is increased five or ten fold and the surplus is divided by the promoter between himself and these various claimants. Anyone will see that the chance of a mine becoming a dividend payer is seriously handicapped by this inflation of its value and all the expense entailed by the organization of a company to be managed by numbers of salaried persons. To pay a dividend even on the par value of the shares a mine must be enormously rich, but when the shares are advanced tenfold the prospect of returns is poor indeed. The literary feature of promotion is well described in the *Review* as follows :

"In estimating the chances, one must never forget that an inexpressibly degraded type of financial press here and in France, has potently aided the great market 'bosses,' 'trusts,' 'banks,' blind pools, underwriting syndicates, and other nondescript combinations in sharpening the appetite of a greedy public, and still aids it. In both countries it is 'so much puff for so much money,' but the French are, on the whole, more economical in their press expenditure than we are, and work the oracle with less unctuous affectation of 'honesty.' Banks and financiers over there openly buy up journals, or the financial pages of journals, and fill them with artistically compiled, or other advertisements of their wares, paid for at the usual wage. In London, it is, with a few glaring exceptions, a locust-swarm of wageless, or low-waged, individual writers who have to be bought ; and the prices these gentlemen, or the owners of certain journals, charge for the use of their pens, or brains, rise with the success of the 'boom.' Our great South African adventurers found most of the financial press lean and hungry, thankful to insert a 'leader' for a ten-pound note, or to publish quotations of manufactured 'share premiums' for half the money. It is quite otherwise now, as the engineers of the 'Western Australian gold mining boom' have found to their cost ; as the leaner sort of promoter sadly admits. A fifty-pound note does not go so far to-day in buying eulogies of new schemes—dressed up in a margarined affectation of impartiality and honest conviction—as a 'fiver' would have done a year ago, and, in consequence, mine-company hatching has become nearly impossible except to very strong cliques. It is not, either, as if the promoter had to do with only a few papers ; he now faces a hoast, all clamorous for hush-money or blackmail. The development of the market excitement has brought into life a swarm of ephemeral prints, which may have little or no money value as agencies for puffing rotten schemes, but whose power for harm might be appreciable were they allowed to speak the truth, or to say all the bad things unsatisfied lusts could dictate. It is necessary, therefore, to keep the poorest rags in tow by paying them extravagant sums to insert advertisements of prospectuses, or for laudatory leaders and 'pars' sometimes written with considerable art, often the merest soap-suddy drivel—in praise of the 'Stonebrooke' mine or the 'Deep Sea' prospecting company, whatever the 'vendors' have to palm off upon the ravenous swarms of brainless gamblers, who hate labor but love 'style' and comprehend good feeding and dukes."

The *Whitehall Review*, chiefly subscribed to by officers and officials, both active and pensioned, warns its patrons as follows :

"The Blackmailer is, for the moment, king. At least a dozen rags, purporting to be financial journals, fatten on the company promoter. If the latter, who is generally of shady antecedents, does not give a £20 or £30 advertisement, the organ of light and leading so floated comes out the next day with a sensational article, and a still more sensational poster, something in this way :—

THE GREAT BONUM MINE, LIMITED.

AN IMPUDENT PROSPECTUS—SOME STARTLING FACTS ABOUT THE PROMOTERS.

If, on the contrary, the financial blackmail journalist gets his check, he will insert an unblushing and generally ungrammatical puff of the Great Bonum Mine, and his leading article and poster will deal with the iniquities of some other company, the promoters of which have not paid their price. . . . The insertion of the prospectus of any venture in these rags is a pretty convincing test that the promoters of that company are afraid of exposure. Of course the prospectus of some other than swindling companies appear occasionally in these organs of blackmail. In that case be assured that the venal advertising agent has included such a paper in his list in order to grasp at a higher discount than is allowed by a respectful journal. A good many of the bogus financial papers which now flood the city are bringing in fabulous sums to their proprietors. If justice were meted out, most of these gentry would be in the dock on charges of obtaining money by threats."

The chance for dividends commensurate with the prices to which South African shares have advanced in the London market is forcibly put as follows by the *Investor's Review* :—

"If the annual gold-production of South Africa rose to £30,000,000 gross,—it is not yet £10,000,000,—and if two-fifths of this, or £12,000,000, were net profits fairly distributable among the shareholders in the 'mining companies,' 'chartered companies,' 'banks,' 'trusts,' and 'finance companies,' whose shares still soar at aerial heights, th money would barely pay 6 per cent. on the recent market prices. But there is no reasonable prospect that the output of gold in South Africa will ever reach £20,000,000 gross, let alone £30,000,000, and still less that two-fifths of the total product can ever be fair net profit ; and there is no ground whatever to suppose that the maximum output, whatever it may be, will be sustained for ten years. A solitary mine here and there may endure for that time, or longer, and pay—most will do nothing of the kind. If the average return to the "investor" is 1 per cent. all over on the market price of the shares, it will be a marvel."

It is of course incredible that the present value of shares can be maintained and it might be supposed that the gold mining industry will suffer by the reaction in prices. But it will be the speculators, left with shares on their hands, who will be the mourners, and for a time it will be difficult to start new enteprises. But the mines that have a good basis of value will operate as well as ever and that there are many such is proved by the returns. Bradstreet's gives the following summary of the history of South Africa Gold Mining :—

"Nearly 30 years ago gold was found to exist in the South African Republic, or, as it is often called, the Transvaal. What are known as the mines of the Lydenburg district, in the eastern part of the Transvaal, were worked as early as 1869. They continued to be moderate producers, yielding an average of about $1,500,000 gold per annum, until they were overshadowed by the Witwatersrand. The latter is a district surrounding the town of Johannesburg, about 35 miles south of Pretoria, the capital of the republic, and on the watershed between the Limpopo and Vaal rivers. It is in the midst of a rolling country, about 5,600 feet above sea level, and, up to the time of the present development, was regarded as useless for anything but grazing. Gold was believed to exist in the region 20 years ago, but it was not till 1884 that any systematic attempt was made to work it. At first the miners and prospectors sought only for rich pockets, which are occasionally found along the outcrop of the reefs, and only after a couple of years was it realized that in the conglomorate rock which accompanied such deposits was the true source of the country's mineral wealth. Several years of exploration, of partial failures and uphill work, ensued, but nevertheless the productiveness of the fields was evident, while they attracted not only a swarm of experienced American and Australian miners but gave employment to increasing amounts of British capital, and presented examples of the highest practical development of science applied to gold mining and extraction. From 1887, when, by the use of primitive methods and appliances, 'the Rand' produced some 23,000 ounces of gold, up to last year, when its output reached a total value of $35,000,000, there has been a growing interest in it which has culminated in the most remarkable speculative excitement of modern times. While attention has been given to West Australia gold discoveries, as well as to the working of the reefs of Mashonaland and Metabeleland (the latter having been partially worked in ancient days by some unknown race) the measure of success that has attended the operations of the miners and prospectors of the Rand has been the chief support to the whole speculative mining movement."

An especial reason why this South African excitement should interest Canadians is the fact that just now large areas in British Columbia are giving evidence of the presence of valuable deposits of gold. In the existing rivers and creeks and in the beds and banks of ancient rivers alluvial gold is found, which by placer or hydraulic mining yields a rich return to the worker. Dredges and pumps are bringing the nuggets up from deep water, and the monitors are washing the gold dust out of the soil. All along the southern borders of the province large bodies of iron and copper bearing rocks are found carrying gold either in good quantities or in sufficient amount to pay if worked economically on a large scale. There are also large districts containing free-milling gold quartz, and a great region with silver-lead mines, which, owing to their high grade and extent, are considered by many to be of surer value than any of the gold mines. The hydraulic and placer gold mines of the Caribou, Fraser, Thompson, Columbia, Tulameen, Similkameen and Kettle Rivers, the gold ore mines of Trail Creek, Boundary Creek and Okanagan, and the silver mines of Slocan in West Kootenay are destined to gain a world-wide fame. Nowhere is capital and the absence of repressive legislation more needed. With free scope for the application

of money, unhindered by restrictions against the building of railroads and the importation of supplies, there will come a development of mineral resources that will astonish the world. But the successful opening up of these riches depends upon the way in which the work is undertaken. If companies are floated on the London plan, at large capitalization and with immense expenses attending their organization and subsequent management, and the selection of the properties they shall work is left to the interested promotors, ghastly failures will soon occur that will dishearten investors and discourage operations. If on the other hand judicious and practical men will take up carefully chosen ground that has not got inflated by boomers, paying moderate prices to the original discoverers and proceeding to work upon business principles, there will undoubtedly be a record of successes that will establish the permanency of profitable mining in British Columbia.

Undoubtedly there will follow a boom, wild company promotion and gambling in shares. But there will exist a solid basis of productive wealth that will ensure a continued operation of mines even if speculators are crushed in the ruins of a declining market.

It is reported that several large companies are already formed in London, with a view to developing British Columbia properties. There is not so much to be hoped from these hap-hazard enterprises as from the intelligent and systematic operations of practical Canadian and American miners, who will work up the mines from small beginnings and avoid the fiascos that are apt to follow operations directed by a board of foreign directors, chiefly remarkable for their titles or their success in gulling the public. It is to be hoped that the preliminary work of opening up the country will be done in a business-like manner, and that our capitalists will be willing to invest their means in efforts to develop legitimate mining operations, rather than risk them by gambling in the shares of companies that have only fictitious or problematical workings as a basis for existence A few successes will bring practical mining men of world-wide reputation to invest their means and devote their energies to the efficient working of the ore bodies. Already the declaring of dividends by the War Eagle mine at Trail Creek, B.C., has brought in the great mining men of the west to buy up neighboring properties; and the interest is extending westward so that we hear of the advent into the Boundary Creek district of such famous names as Marcus Daly, John A. Finch, Farrell and Midgeon, and other mining kings of America.

Premier Turner of British Columbia when in England lately said: "What is wanted in order to attract more attention to the province is some actual returns in the form of dividends from some of our large new mines. When this is forthcoming, which will, I believe, be very soon, we shall have a proportionate boom in the precious metals of British Columbia to that which is taking place with regard to South Africa. At the present time South Africa is, to a certain extent, attracting a great deal of capital which we should like to draw to British Columbia I have been talking to several parties interested in South African mines, and on my suggesting that probably a great deal might be lost, as there is so much gambling in mining stocks, and that it would be better for them to transfer their investments to British Columbia, the invariable reply is:— 'Large fortunes have been and are being made in South Africa, not only by members of the stock exchange, but large dividends have actually been paid to the shareholders at home.' When capitalists see the published returns of these companies they naturally think that South Africa is the best place for them to invest in. What we want in order to divert attention to British Columbia is to have a good output from our mines and to have it made known, and thus to show that British Columbia mines can pay dividends, thereby giving an opportunity of our figures being compared with other mineral producing countries."

The effort of those interested in Canadian mining progress should be to encourage the working of promising mineral prospects and to discourage all legislation that increases the cost of mining or prevents the building of lines for transportation. Great districts are waiting for the advent of railways. The ore is of too low a grade to bear the cost of wagon hauling, packing by horses and raw-hiding. But with the coming of the railroad, we shall see the smelter, the concentrator, the cyanide and chlorination works, and perhaps even the electric smelter, taking hold of the hitherto neglected rocks, and by the new, cheap and effective processes they will pour out wealth that will place Canada in the front rank of the mining countries of the world.

It is not only in British Columbia that the mining boom will strike. From the Atlantic to the Pacific mineral wealth abounds throughout Canada. The coal of Nova Scotia, the Northwest and the Pacific coast; the gold of Nova Scotia, Chaudiere in Quebec, Hastings County, Rainy Lake and Rat Portage in Ontario: the nickel of Sudbury; the iron of Ontario; and many silver mines scattered along the great lakes—all these invite the attention of the investor who would seek wealth from the rocks.

Our plea is for work in intelligently conducted mines, rather than for gambling in the shares of companies solely promoted, not to mine in the earth but to burrow into the pockets of those who have the greed for gain without the ennobling sentiment of producing wealth.

Advice may be given in consideration of the foregoing remarks to two classes of people: First, to the owners of mining prospects or partially developed mines. Do not go to London to sell your properties at a large figure to grand companies. The large price is usually on paper and the vendor is fortunate if he gets away with the coat on his back. The chance of successful working of the mine by a company organized with a large capital and managed expensively by absentees is very small. It is the fashion to decry the efforts of Americans in Canada and to appeal to the patriotic sentiment of "British capital for the British empire." But a true spirit of loyalty would welcome the speedy development of the country and would welcome a foreign capitalist or an American railway, if by their means mines could be worked that would otherwise be idle for years. Considering that the capital invested in initial enterprises is very apt to be lost, there should not be any reluctance to letting strangers take the risk.

The following advice, written to a Canadian mine owner by one of the most eminent mining experts in the United States is pertinent here: —"I think that it will be far better to have the property taken up by a live American syndicate or company, than by one of those English development companies to which you refer. The latter would take forty years getting to work, while the American company will be working the property for all it is worth before the English company could get through wrangling about formalities and holding long-winded meetings of directors, who know about as much of what they are discussing as a monkey knows of the man in the moon."

If the owners of mining property would consent to take a large proportion of its price in shares of the company, thus sharing in the risk and profits of the work, a vastly greater number of operations would be undertaken and much larger sums would sometimes be realized by the vendor. Capitalists will put up money to work but they are loth to pay it out in advance for the privilege of working.

Secondly, the lesson to capitalists who wish to do legitimate mining is never to invest in an over-capitalized and grandly officered company. If they wish to gamble in shares the company with the greatest amount of buncombe may be the best, but if they seek dividends from mining operations let them get near to bed-rock and know the men who are in charge.

But men will gamble rather than work and wait, and in spite of all preaching the boom will come. Colorado will produce as much gold as South Africa, and British Columbia has perhaps an even greater capacity. The boomsters have their eye on these quarters, and if public interest is aroused by large returns of profit, speculation in shares and the organization of wild-cat companies is sure to follow. In spite of the disasters that eventually come from these efforts, a certain amount of good results to the country from the expenditure of money, and, what is one man's loss is another man's gain. At any rate it is well to understand the true meaning of these movements, and such articles as that in the *Investor's Review* are valuable and timely.

Gold Mining in Nova Scotia.

Through the courtesy of Mr. W. H. Brown, Accountant of the Mines Department, Halifax, we are able to furnish our readers this month with a complete return of the quartz crushed and the yield of gold therefrom as reported to the Department from 1st January of the present year to 30th September last. As some of our readers last year claimed that their returns, although reported for the year, only represented a certain number of months actual work, we have in this statement taken pains to show the months for which returns have been officially reported. In order to prevent misconception it is well to remember that our figures must not be confounded with those given in the Mines Report, which cover the fiscal year ended 30th September. Our returns, which are for the nine months of the present year, are as follows :—

Name of District.	Name of Mill or Co.	Months in which Crushing was done and Returns Made.	Quartz Crushed.	Yield of Gold.	Total Yield.
			No. of Tons.	ozs., dwts. grs.	ozs., dwts., grs.
Sherbrooke	McNaughton Co	Jan., Feb., March, June, July, Aug., Sept	665	458 10 0	
	Stellarton Gold Co	Jan., Feb., March, April, May, June, August	1,904	903 9 0	
	New Glasgow Gold Co	September (only)	150	101 0 0	
			2,719	1,462 19 0	1,462 19 0
Oldham	Concord Mill	January (only)	5	4 12 4	
	Oldham Gold Co's Mill	Jan., Feb., March, April, May, June, July, August	324½	168 13 0	
	H. Whidden	Gold mortared during the month of June	.....	1 13 15	
	J. Dowell	" " " "	.....	4 4 15	
	J. E. Vandegrift	" " " June, July, August	.....	18 11 7	
			329½	197 14 17	197 14 17
Waverly	Tudor Gold Mining Co	Jan., Feb., March, April, May, June, July, Aug., Sept	4,457½	989 7 0	989 7 0
Moose River and Caribou	Moose River Gold Mining Co	Jan., Feb., March, April, May, June, July, Aug., Sept	1,645¾	443 10 0	
	Damas Touquoy's Mill	Jan., Feb., March, April, May, June, July, Aug., Sept	3,599	298 9 12	
	W. A. Sanders "	Jan., April, May, June, July, Aug., Sept	3,146½	376 13 0	
	Gardner Clish's "	Jan., Feb., March, April, May, June, July, Aug., Sept	314	281 4 0	
	A. M. Jack's "	April, May, June, July, August	522	110 10 15	
	H. Dixon's "	Jan., Feb., March, April, May, June, July, Aug., Sept	734	901 10 0	
			9,961¾	2,411 17 3	2,411 17 3
Uniacke	J. J. Withrow "	Jan., March, April, May, June, July, Aug., Sept	381	428 18 6	
	Golden Lode "	Feb., March, April, May, June, Aug., Sept	151	1,309 9 8	
	T. R. Prince's "	Jan., Feb., March, April, May, June, July, Aug., Sept	1,676	191 11 0	
(Phœnix.)	John Madill's "	May, June, July	496	12 15 15	
	Eastville "	Jan., Feb., July, August	105	64 2 22	
	D. McDonald's. "	May, July, August	25½	15 5 18	
			2,828½	2,022 2 21	2,022 2 21
Lake Catcha	John H. Anderson's "	Jan., Feb., March, April, May, June, July, Aug., Sept	640¼	467 9 0	
	Oxford... "	Jan., Feb., April, May, June	310¼	88 1 0	
			950¼	555* 10 0	555 10 0
Stormont	Richardson Gold Min. Co's Mill	Jan., Feb., March, April, May, June, July, Aug., Sept	7,806	1,248 0 0	
	Eureka Co's "	Feb., March, April	137½	68 14 12	
	John McMillan's "	February	56	18 16 0	
	Antigonish Mg. Co's "	January, February	705	237 3 0	
	Jas. A. Macdonald's "	June, July, August, September	70¼	68 12 0	
(Modstock Co.)	J. D. Copeland's "	June, July, August, September	1,042	764 0 0	
	Country Har. Gold Mg. Co's "	January, February, March, April, May	1,279	374 5 0	
			11,095¾	2,779 10 12	2,779 10 12
Brookfield, (Queen's)	W. L. Libbey's "	Jan., Feb., March, April, May, June, July, Aug., Sept	2,869	1,699 2 10	
	Philadelphia "	May, June	100	19 18 0	
			2,969	1,719 0 10	1,719 0 10
Beaver Dam	Beaver Dam Co's "	Jan., May, June, July, (August from plates)	432	46 4 21	46 4 21
Montague	Nova Scotia Gold Mines "	Jan., Feb., March, April, May, June	673½	276 10 0	276 10 0
Malaga	Malaga Mining Co. "	August, September	90	44 2 0	44 2 0
Kemptville	Kempt Mg. Co's "	April, June, July, Aug., Sept	149	101 15 15	101 15 15
15 mile stream	New Egerton Co's "	Jan., Feb., March, April, May, June, July, Aug., Sept	3,522	1,967 14 0	1,967 14 0
Renfrew	Pictou Dev. & Mining Co's "	Jan., Feb., March, April, May, June, July, August	847	956 12 0	956 12 0
Wine Harbor	New El Dorado "	January, February, March	265	112 4 11	112 4 11
Tangier (proper)	Essex "	May	40	11 14 0	11 14 0
Mooseland—Tangier	Mooseland Gold Mg. Co's "	May, June, July, Aug.	1,690	92 5 5	92 5 5
Gold River	T. N. Baker's "	June, July, August, September. (No quartz filled in for Aug. and Sept.)	37 June and July	120 3 0	120 3 0
Liscomb Lake	John Power's "	August and September	27	11 8 10	11 8 10
					13,099 4 17

Since we received these figures we are advised of additional returns from A. M. Jack's Mill at Caribou for September as follows :— 35 tons quartz, yielding 40 ounces of gold, making the output from this mill for the six months, 150 ozs., 10 dwts., 15 grs.

The Iron Industry in Nova Scotia.

This industry, in common with the coal trade, has experienced the dullness which has prevailed over the American continent. It is pleasing to note that it has recovered and is at present prosperous.

During the twelve months under review the New Glasgow Iron, Coal and Railway Company has been united with the Nova Scotia Steel Company, the enterprise which Nova Scotians can justly point to as probably the most successful joint stock enterprise ever launched in the province. This company is extending its operations and is supplied with an admirable Bessemer pig from its furnace at Ferrona The possibility of lengthening the runs of this furnace on steel material is in itself an item of economy, rendered feasible by the growth of the steel works. The furnace was started again in the summer and ready sales of pig are since reported. After a long vacation the Londonderry works went into blast again, and it is reported are contemplating the reopening of their rolling-mill. The large contract secured by this company for the pipes of the new gas company in Halifax will keep their foundry running for some time. The charcoal furnace at Bridgeville, Pictou county, had a short campaign of about a month. As yet, however, the price of charcoal pig has not recovered itself sufficiently to permit of their continuous operation. It may be questioned if the admirable pig made here would be available for steel making, as is the case with some of the better Swedish brands.

The Torbrook mine has been running steadily with a total output of 29,940 tons divided between Londonderry and Ferrona. The vein worked at this mine improves in depth, in quality and thickness, and has been found to extend about three-quarters of a mile to the westward of the present works.

The Nova Scotia Steel Company have suspended operations at their Arisaig mines, having discovered a deposit of iron ore of higher grade at Bell Island, near St. John's, Nfld., which they are opening for shipment next spring.

The production of pig iron stands as follows for the twelve months ended Sept. 30th, 1895, although the output is more truly for the last six months of that period :—

	Tons.
Pictou Charcoal Iron Co.	323
Nova Scotia Steel Co.	17,321
Londonderry Iron Co.	11,446
Total	29,090

Returns so far received show that during the year there were 79,636 tons of ore mined, of which amount the Charcoal Company, in addition to 598 tons smelted, mined and sold 7,541 tons. There were 36,532 tons of coke reported from the Pictou coal mines and the Ferrona furnace, and about 25,050 tons of limestone quarried.

It is anticipated that the Londonderry and Ferrona furnaces will make a large and steady output for some time; so that next year's operations, which have already made a promising start, will make the best returns yet shown.

Little has been done with any of the other well-known iron deposits of the province. The furnaces are well supplied with ore, and freight considerations prevent much competition for local furnace supplies. Should the scheme of building a blast furnace at St. John be carried out, there is no doubt that the iron ores of the Bay of Fundy will be largely drawn upon, and should the prices of iron in the United States continue to rise, a demand will be made for high grade and conveniently situated ores in Nova Scotia. In this connection may be mentioned the accessible and purer deposits of Torbrook and Nictaux, and the ores lying between Maitland and Windsor.

Coal Mining in Pictou and Cumberland Counties, N.S.

The returns so far as can be gathered at date of writing do not show the coal trade of Cumberland and Pictou as specially flourishing during the twelve months ended September 30th, 1895. The output of the Springhill mines was necessarily interrupted by the destructive bank head fire, and in Pictou county the prevailing dullness of trade, and the keen competition of Cape Breton coal at common points, contributed to keep the production down.

The total sales of Cumberland coal for the year were about 422,210 tons compared with 479,350 tons in 1894, a falling off of 57,140 tons. In Pictou county the sales were about 367,205 tons, as compared with 412,039 tons during the preceding year, a deficiency of 44,834 tons; the total shrinkage in sales for the two counties being about 100,000 tons.

The Londonderry furnaces were idle from Oct. 1st, 1894, to March 9, 1895, and the Ferrona furnace was also out of blast for some time. This lessened the sale of slack for coke and other iron making purposes from both counties. It is anticipated, that the demand for coke will be steady during the winter and that the Cumberland collieries will have to work full time to complete railway stocks and to supply local consumers.

At the Joggins mines operations have been interrupted several times, but attention has been paid to the important matter of having plenty of coal where it can be promptly extracted when needed. At the River Herbert mine Mr. Hall has deepened his slope 200 feet, and expects to work steadily during the winter. At the other small mines, as usual, a few hundred tons are sold during the cold weather. At Springhill the coal has been drawn through the No. 1 or East slope, and a large amount of the coal left years ago in the pillars has been successfully robbed. The bank head at the north slope has been rebuilt and is again in working order. With these two openings the company will be in a position to meet all demands made on it.

In Pictou county work was continued as usual at the Intercolonial Coal Co's mines. A coal washer was put in and other improvements, with a view to reducing working expenses. The Acadia Co. has rebuilt the bank head lost about a year ago, at their Westville mine, and this veteran slope is still turning out a regular supply of its well known fuel. At the Third and McGregor collieries at the Albion mines operations are being continued in the usual quiet style. Operations commenced at some expense in the main seam to the westward of the Foster pit were stopped, as the coal did not prove good enough to work. In the Foord pit workings the fan shaft was made air-tight, and arrangements made for building off a connection with the older workings so that air being excluded the water in these workings could be lowered sufficiently to permit of the workings in the third seam being extended for about 500 feet to the dip. At the Vale colliery work continued dull all the season. The seam has thinned considerably, and proves expensive to work.

American Metallurgy.

The series of lectures entitled "Recent American Methods and Appliances Employed in the Metallurgy of Copper, Lead, Gold and Silver," delivered by Mr. James Douglas before the Society of Arts, and which have been published in the recent issues of the Society's Journal, are full of interest and contain a mass of very useful statistics of costs. Mr. Douglas fully appreciates a fact which is too often overlooked in comparing American methods with English and German methods. He says, "What is true of mechanical appliances is equally so of certain metallurgical processes admittedly American, some of which —while valuable, because peculiarly adapted to local or even special climatic conditions—are not so accurate and economical as to receive

the stamp of general acceptance. There are, in fact, two standards by which metallurgical as well as other technical processes and practices are to be judged—the standard of absolute excellence and that of economical utility. The series of operations by which the minutest trace of each valuable constituent of an ore is recovered, represents no doubt the highest standard of the art of metallurgy; but on the other hand the process by which the most money can be made out of an ore in a given locality is generally awarded in practice the reward of adoption, even though it be wasteful and reprehensible from a scientific and technical point of view. Remembering that most of the larger mineral deposits of the United States are situated far from the centres of population and of chemical industry, where, therefore, by-products are of little or no value, where fuel and re-agents are dear, and where labor, owing to its scarcity and the great cost of living, commands higher wages than in any other section of the Union, it can readily be conceived that the simplest, not the most complicated, even though it be the most perfect; the speediest, not the most thorough process will be selected, with a view to saving only the most important constituents of the ore, regardless of its subsidiary and less valuable elements. Men who risk their money, and those who forfeit their comfort to recover what Nature has hidden in the wilderness are liable to overlook small savings in their hunt for wealth, and to be guilty of committing the crime of permitting heavy metallurgical waste so long as it does not involve pecuniary loss."

In dealing with copper concentrating at Lake Superior Mr. Douglas gives the costs of mining and concentrating at the Atlantic mine which are certainly worth reproducing. The ore is broken in a rock-breaker, crushed in steam stamps and concentrated by jigging in Collom jigs and the slimes by round buddles. From 200 to 300 tons of ore are crushed daily.

The following was the output and working cost last year:—

Rock stamped.....(tons)	315,626
Product of mineral.....(pounds)	5,687,665
Product of refined copper.....(pounds)	4,437,609
Yield of rock (per ton).....14 pounds—	0.703%
Total cost of mining, selecting, &c.....	$0.7518
Transport to mill.....	0.0303
Stamping and separating.....	0.2330
Total cost of mining and concentrating.....	1.0151
Freight, smelting and marketing.....	0.1771
Total cost of mining, treating and marketing the product, per ton.....	1.1923
Gross value of product.....	1.3376
Profit per ton.....	$0.14

Turning from the concentration of copper ores to that of galena, the methods and cost of working at the St. Joe mine are given, here the ore is crushed dry and screened through trommels with six more holes, then wetted and concentrated, and sized in 92 two-compartment jigs. Prof. Munroe, of Columbia College, attributes the success of thus jigging coarse and fine, including slimes, to the coarseness of the bed. He says: "The plan of jigging sands and slimes together, makes it possible to treat very much finer material with success, than has heretofore been supposed possible. The limit of successful work on jigs is generally placed at 1 mm. The successful jigging of stuff ⅛ mm. and less marks a decided advance in the art of dressing. The coarse grains form the intestrial channels in which this very fine stuff can be concentrated. It is well known that any attempt to treat stuff finer than 1 mm. by itself, results in very imperfect working of the jigs, the losses being large and the capacity of the jig small. The advantage of this system of jigging is the large proportions of sands successfully treated and finally disposed of by the roughing jigs alone. Out of 800 tons per day, only 136 required further treatment, viz: 30 tons raggings crushed and treated on the 3-sieve jigs, 66 tons of fine sand, also treated on the 3-sieve jigs, and 40 tons of slimes treated on the side bump tables"

The cost of concentrating is 36.4 cents per ton, being 13·1 cents higher than at the Atlantic mine.

The author next deals briefly with gold hydraulicing and the milling of free gold and silver ores. He strongly condemns the policy of the owners of the Comstock, where he considers that metallurgical economy has been subordinate to the exigencies of speculative owners and stock manipulators, who have required an enormous output, even though it involved heavy operating losses.

In dealing with calcining furnaces Mr. Douglas confines himself to three types, namely, rake furnaces, shaft furnaces with long drop, and cylinder furnaces. The most popular rake furnaces are modifications of the O'Hara. The Brown-Allan, O'Haras as used at Butte, are constructed with two hearths 100 feet long and 9 feet wide, with four fire-places, two on each side of the upper hearth They roast from 45 tons to 50 tons of concentrates per day, reducing the sulphur to 6 per cent. In some furnaces the lower hearths are produced beyond the limits of the furnace to serve as a cooling floor. When employed for roasting preparatory to smelting, the floor of the lower hearth may terminate in a hopper, whence the accumulated hot ore drops into reverberatories.

Mr. R. Pearce, of Argo, has designed a turret furnace, from which very good results have been obtained. In this furnace the machinery imparts a revolving motion to radial arms and ploughs; the arms are hollow tubes through which air can be forced on the surface of the ore at a certain stage in the roast, thus cooling the arms and ploughs and accelerating oxidation. The fireplaces supply extraneous heat. These furnaces may be built with several hearths above each other, thus prolonging the roasting where complete oxidation is required. Mr. Pearce says, "The turret roasting furnaces have been in constant operation at these works (Argo) for a period of about three years. I have had ample opportunities of testing their capacity on ores and mattes of different kinds The following results have been obtained from runs of sufficient quantity of material to ensure their correctness, and they are certainly very conservative. To test the capacity of the furnace for roasting, I made use of Gilpin County tailings containing 79·5% of pyrite, representing 42·1% of sulphur. Of this material the furnace was able to roast 9·8 tons per 24 hours down to 0.22% of sulphur at a cost of $1.15 per ton."

"Pyrite containing little or no foreign elements carrying 46% of sulphur, has been roasted to 4·46% of sulphur, at the rate of 14·76 tons per day and at a cost of 71 cents per ton."

"An ordinary mixture of ores, containing pyrite with from 20 to 30 of silica may be roasted to 4.75% of sulphur at the rate of 16 tons per day and at a cost of 70 cents."

"Matte containing lead to the extent of from 10 to 15% and 30 to 35 of copper, has been roasted to 6% per cent of sulphur at the rate of 13 tons per day and at a cost of $1.00."

The following table is well worth reproducing as it gives the cost and efficiency of four kinds of rake calcining furnaces in use in America:

			Improved.	
	Reverberatory.	Old Spence.	Segmental.	Rectangular.
Cost of construction at Butte	$4,500 00	$2,500 00	$8,500 00	$10,000 00
Yearly running time.	360 days.	320 days	340 days	360 days
Daily gross capacity	10 tons.	7 tons	30 tons	43 tons
Labor for 24 hours furnace and tramming	$ 9 33	$4 38	$11 50	$9 95
Fuel	10 00	None	1 00	2 50
Repairs and shut downs	1 00	$3 00	2 50	1 25
Power	None	2 50	1 00	1 00
Sinking fund (6 per cent.)	$0 79	0 42	1 42	1 67
Total Expenses	$21 12	$11 30	$17 42	$16 37
Cost per ton	2 00	1 91	0 58	0 41

In dealing with revolving furnaces Mr. Douglas instances the Bruckner with intermittent feed and discharge and the White-Howell with continuous feed and discharge. Both types do good work The former is used more as an oxidizer, while the latter is useful as a chlori

dizer. The White-Howell gives an output of nearly 40 tons per day, and the Bruckner 20 tons, while an ordinary reverberatory rarely exceeds 10 tons. The Stetefeldt (which is a shaft furnace in which the ore drops down a slightly coned shaft 48 feet high and meets a heated oxidizing or chloridizing atmosphere) has a capacity of from 70 to 100 tons per day.

For the chloridizing roasting of silver ores the author favors the Stetefeldt above all other types.

Following this comes an interesting article on the chlorination of gold and silver ores. A good account is given of the Russell process, which consists of leaching with a double sulphite of soda and copper ($2Na_2S_2O_5 . 3Ca_2S_2O_5 5H_2O$.) This double sulphite is not only more active in dissolving silver chloride, but it violently attacks native silver, as well as the sulphide and double sulphides of silver with arsenic and antimony.

By far the ablest part of these lectures is that portion devoted to copper smelting.

Mr. Douglas deals briefly with the methods adopted by the Anaconda Co., the Orford works, the New Jersey Extraction Co., the Nicholls Copper plant, the Pennsylvania Salt works, the Parrot Company of Butte, Messrs. Lewisohn and others, in the east. At the Orford works large brick matting furnaces are used, and the regulus is brought up to blister in the reverberatory. The argentiferous and auriferous copper is cast into anodes which are electrolyzed at the Balbach works in Newark. In addition to this they make a brand of cast copper which ranks with the best selected of the English smelters. The refining capacity is about 3,000,000 lbs. of copper monthly.

Thanks to the introduction of the low water-jacketed cupola furnaces the western people are now capable of smelting copper at the mines, and the eastern smelters are no longer able to rely on the west for their supplies, so have to import foreign ores. In the west the ores are almost entirely smelted in Piltz furnaces (a water-jacketed cupola). The copper is tapped directly from the crucible through a tap-hole generally 18 inches below the tuyers. The slags are often rich in copper. Mr. Douglas says, "It inevitably follows that the slag drawn from a hearth through which particles of 96 % copper are falling must be rich. The operation was wasteful, but none other under the conditions was profitable. The large furnaces of the Detroit Copper Co. have a small fore-hearth, the water-jacketed shell of the furnace serving as a tymp. This allows the copper a better opportunity of settling, but the advantage is slight." Mr. Douglas continues by giving a lengthy account of the construction of the furnace followed by copper smelting in Montana, the bessemerizing of copper mattes and pyritic smelting in Colorado, which lack of space prevents our going into. He also gives an excellent account of several wet processes, such as the Mounier, Whipley & Stover, Hunt & Douglas, Ziervogel-Pearce, Crook, and the manufacture of copper sulphate.

Turning to the metallurgy of lead: In the Missouri, Mississippi and South Kansas districts, which produce 20% of the lead smelted in the United States, no less than 62.47% is smelted in a modified Scotch hearth, so altered as to entitle them to the distinction of being American furnaces operated in a distinctly novel manner.

Mr. Douglas gives the following description of the furnace:—"The simpler hearths of this district differ from the old pattern only in that the walls of the well and tuyer-back are water-jacketed. Thus the operation is not interrupted at short intervals to permit the hearth to cool. But a much more radical departure from the simple hearth has been made by E. R. Moffet, of the Pitcher Lead Co's works, formerly of Lone Glen Co's works at Joplin. The Moffet hearths are built back to back and discharge into a common stack. The lead-well of iron is suspended between four pillars and cooled by exposure to air; while in a hollow back, which forms the partition between adjacent hearths, the blast is heated. This hearth, with the same amount of labor, treats more than twice as much ore as hearths operated by the cold blast. But the percentage of lead recovered as metal is only half as great. This, however, is an advantage, as the fumes, after being cooled by passing through coils of iron pipe, are forced and collected into bags of the Lewis & Bartlett white lead apparatus. These discolored fumes, with the rich grey hearth slag and some crude galena, are extracted in a slag furnace constructed with double tiers of tuyeres in which as much lead as possible is volatalized. The fumes issuing from the cupola, after parting with their heavier particles in a brick chamber and flue, are burnt so as to oxidize suspended carbon dust and to convert lead sulphide into lead sulphate before being cooled and forced by a fan into a series of woollen bags. The composition of the Bartlett blue power and white lead is given by Hoffman as follows:—

	Roasted Blue Powder.	Refined White Lead.
Insoluble.	——	0.08
$PbSO_4$	48.76	65.00
PbO	46.82	25.89
ZnO	0.27	6.02
Fe_2O_3	0.32	0.03
CaO	0.48	0.02
CO_2	0.90	2.00
SO_3	1.65	——
N_2O	0 37	0.85
Al_2O_3	0.05	——
SiO_2	0.10	——

The slags from the furnace are said by Holibaugh to be practically clean; and as all the lead fumes from both the hearth and the slag-furnace are caught and converted into a saleable product, one of the main objections to the Scotch hearth (its wastefulness) is removed."

In Leadville, Denver and Pueblo, mechanical furnaces of various types are used to roast and matte the ore, but hand furnaces are much more widely retained in lead than copper works.

"The smelting furnaces are large cupolas, originally designed on the Raschette model, then verging towards the Piltz, and finally reverting to the Raschette type. . . . A usual size is now 40 × 120 inches. All are built with a bosh and all are jacketed within the zone of fusion. Most are provided with the Avento syphon tap, a discharge built into the crucible wall and communicating with the bottom of the lead well. In all the superstruction is supported on pillars to facilitate the removal of defective sections. In most establishments coke and charcoal mixed is the fuel, but in one instance, at least, uncoked lignite, mixed with coke made from the same is used very successfully."

Desilverizing the lead is done by the Parks process. The size of the kettle has been increased from 12½ tons capacity to 30, and in a few instances 45 to 50 tons. The kettle is discharged by the Steitz syphon. Base bullion running 300 oz. silver and gold is desilverised by two zinkings, if no separate gold crust is made; otherwise by three. The methods of liquating the crust has been improved and retorting the argentiferous zinc has become an established method of work.

EN PASSANT.

We take pleasure in announcing to our readers the appointment of Mr. F. H. Mason, F.C.S, Halifax, as Associate Editor Mr. Mason, in future, will have charge of our Nova Scotia correspondence.

The ordinary general meeting of the Mining Society of Nova Scotia which was to have taken place at Halifax on 21st instant, has been postponed until Thursday, 4th December, when we trust there will be a large attendance. Among the papers to be presented we notice "The Capacity of Coal Cutting Machinery," by Mr. W. Blakemore, M.E., Assistant Manager, Dominion Coal Co., Ltd.; "A Mineralized Zone in Nova Scotia, by Mr. H. S. Poole, M.A., A.R S.M., Manager Acadia Coal Co., Ltd.; and "A Cable Hoist as applied to Low Grade Ore," by Mr. C. E. Willis, M.E.

Nearly twenty papers have been promised for the next meeting of the General Mining Association of the Province of Quebec to be held in Montreal during the second week in January. As in former years the meeting will last for three days.

A feature of this meeting will be the Student's Session, when papers will be submitted in competition "for medals and other rewards," a grant of fifty dollars having been made for this purpose. This competition is open to any Canadian student for original papers on subjects connected with mining, mineralogy, chemistry and such other matters as may come within the scope of the profession of mining engineering. A number of entries are promised from McGill, and it is hoped the Mining School at Kingston, and other technical schools will also be represented.

Mr. J. Burley Smith, M.E., of Glen Almond, who has for a number of years been manager for the British Phosphate Company in this country, sends us the following wire from Nipegon, Ont., received too late for insertion in our last number: "Kindly announce in current REVIEW that I have discovered an outcrop of the celebrated Sultana gold quartz lode on two islands slightly southwest of Sultana mine and have acquired both. Mining operations will promptly commence. Sultana gold brick, last week's working, 10-stamps, $2,450."

Mr. W. Penn Hussey, managing director of the Broad Cove Coal Co., Ltd., Cape Breton, was in Ottawa during the month arranging with the Government for the dredging of the proposed shipping harbor at Broad Cove.

Mr. John Blue, C. & M.E., of the Eustis Mining Co., Capelton, President of the General Mining Association of the Province of Quebec, passed through Ottawa on 20th instant on a visit to the Lawn silver mine, Calumet Island, Que.

The shipments of Canadian phosphate during the season will aggregate about 1,000 tons. The Phosphate of Lime Co., through Wilson & Green, made one cargo of 271 tons, 80%, to Liverpool, and Mr. J. S. Higginson, Buckingham, 250 tons 80%, to the same port. The other shipments supplied Canadian and United States consumers. The last reports of the European market are very bad, 80% being quoted at 6½d. per unit delivered at Liverpool and no rise over 80%. Florida is being pressed for sale at 6⅛d. for 75–80%, delivered in the Mersey. The United States markets have also been very depressed, Tennessee phosphate completely shutting us out of both Chicago and Buffalo, where this product is being offered at $7.00 for 65–70%, delivered grouud. Freight to Chicago at $3.25 and grinding charges $2.25 leaves very little to be made by phosphates at this price.

Mr. W A. Carlyle, Mining Engineer, Montreal, has, after some hesitation, accepted the position of Government mineralogist, offered to him by Col. Baker, Minister of Mines for the Province of British Columbia. Mr. Carlyle graduated from McGill University in 1887, having gained the British Association gold medal for proficiency in engineering subjects, and also first class honors from Sir William Dawson in natural sciences, viz., geology, mineralogy, chemistry and petrography. After two seasons' work on the staff of the Geological Survey, he became mining engineer for Mr. D. R. C. Brown, Aspen, Colorado, one of the largest and most successful mining operators in that State, and while there he was constantly engaged in the various operations of mine engineering, mine examinations, surveying and lawsuit work in the largest mines in that famous camp. At Aspen Mr. Carlyle put in the dams, flumes, ditches, pipe lines, etc., of a water supply sufficient to generate 2,000 h. p. of electric power, Aspen being the first place on the continent to introduce successfully the general use of electricity in all mining work. He was also connected with the construction of a large mill for the concentration of low grade ores, and spent a considerable time in making a complete survey and geological examination of Smuggler Cut in Colorado for Mr. Brunton, a prominent English engineer, who specially sent to Canada for Mr. Carlyle to take charge of the work. In relation to this service Mr. Brunton says: "Mr. Carlyle has made for me maps, geological sections and models of many mines in this district and in other parts as well as in Montana. For the past two years he has been engineer for me upon the Cowenhoven M. T. & T. D. Tunnel Company and the property of the 'Della S. Mining Company,' all the works of which he has completely mapped, sectionised and modelled. All the work has been performed in a most satisfactory, manner, and it is with deep regret that I learn of his intention to return to Canada. Mr. Carlyle has thoroughly familiarized himself with the different methods of mining, valuing mines and treating precious metal ores, and in short has lost no opportunity of studying the details of his profession, and I can heartily recommend him for any position connected therewith." Mr. Carlyle was afterwards appointed professor and lecturer at McGill University on mining and metallurgy, which appointment he now holds, and he was specially recommended by Dr. Dawson and the President of the University as peculiarly fitted for the appointment of Provincial Mineralogist for British Columbia. His duties will consist of visiting and inspecting the mining districts of the Province and reporting to the Minister of Mines on the same, and his official reports will be available for the information of the public. In 1892 Mr. Carlyle visited professionally the iron and copper mines of Lake Superior; in 1893 he worked in the gold mills of Central City and afterwards in the smelters at Denver; in 1894 he visited some mines in New York and other States, and also in eastern Canada, and the late summer vacation he has spent professionally in the Black Hill country in the United States.

In Mr. Carlyle the Government of British Columbia has secured a sound, conscientious engineer of considerable ability, whose services will be of the greatest value in the new department to which he has been appointed.

The discovery of large and valuable deposits of chromic iron ore is reported to have been made lately on the west side of Port-au-Port Bay, Newfoundland. The dispatch says: "The length of the seams (?) is 240 ft. on the surface and there are eight veins (?) varying in width from 5 to 12 ft. of solid 'piece' ore, of which 7 cubic feet weighs a ton. An excavation of 8 ft. has been made, indicating a widening of the seams (?). The mine is just a mile from the water, and the ore will be conveyed half way by trolley, and then by an endless cable, lowering it into the ships without a wharf being necessary at all. When spring opens 400 men are to be put to work."

An interesting example of the electrical transmission of power is being carried out by Messrs. Johnson and Phillips, of London and Charlton, at the Sheba gold mines, ten miles distant from Barberton, South Africa. This installation is described in an illustrated pamphlet issued by the firm. Hitherto the ore has been conveyed to the stamps, a distance of three miles, by means of an aerial tramway, but the development of the mines has been so great that the directors of the Sheba Gold Mining Company decided early last year to lay down additional stamps, not on the site of the then existing stamps, but at the mine itself, and to transmit the power for working them by means of electricity. The electrical energy is transmitted through five miles of underground cable, curving round the hills from the Queen's River. The available water power is estimated at about 600 horse power, and two 300-horse power turbines have been laid down for driving the generators. The power-house, which has been built on a slope by the Queen's River, contains two alternators, and the current is transmitted to the receiving-house at the mine. Here the pressure is reduced by means of transformers, and electrical energy is conveyed by other cables to different points for the operation of motors working the stamps, pumps, settlers, breakers, etc.

Prof. W. A. CARLYLE, B.A.Sc., M.E.

Government Mineralogist to the Province of British Columbia.

MICA MEN IN SESSION.

Standard Grades and Uniformity in Prices Discussed.

Under the auspices of the General Mining Association of the Province of Quebec a meeting of Canadian Mica Producers was held in the Russell House, Ottawa, on Thursday afternoon, 14th instant. Captain Robert C. Adams, Montreal, Vice-President, in the chair. There was a large attendance; among others present being noticed: Mr. T. G. Coursolles, (Wallingford Mica Co.) Ottawa; Mr. Lewis K. McLaurin, (McLaurin Mine) Templeton; Mr. Davidson, (Vavasour Mining Association) H Bumgarten, (Canadian Mica Co.) Ottawa; Lt.-Col. Wright, (Cascades Mica Co.) Ottawa; W. Wallingford, (Wallingford Mica Co.) Templeton; S. P. Franchot, (Villeneuve Mica Co.) Buckingham; W. F. Powell, (Clemow & Powell) Ottawa; J. Burley Smith, M.E., Glen Almond, Que.; E. B. Haycock, Ottawa; C. A. Chubbick, Ottawa; F. Cirkel, M.E. Ottawa; Don. C. Watters, (Lake Girard Mica System) Ottawa; F. Clemow, (Clemow & Powell) Ottawa; E. D. Ingall, Chief of the Mining Bureau Geol. Survey of Canada, Ottawa; W. Sears, Ottawa, and B. T. A. Bell, Editor CANADIAN MINING REVIEW.

CAPTAIN ADAMS, in opening the proceedings, said he was glad to meet so many gentlemen who were active workers in mica. He had had something to do with the mineral in the past, and having tender memories of past experience, he expressed his pleasure at meeting gentlemen who were successful. He would ask Mr. Bell, "the power behind the throne," to explain to them exactly the object of the meeting. As he understood it it was to consider in what way the mica business could be advanced by coming to some understanding with regard to prices. When he sold 200 tons for 75 cents a ton it was before mica was used for electrical purposes, and we have all seen it grow from that time until now the price amounts into the hundreds of dollars, and it would seem desirable that there should be a conference of those interested in the matter to come to some understanding—to see what it really is worth, what its market value is, so that a price might be established which would tend to prevent a slaughter of the material and enable all to get a just price without attempting to engage in extortion.

MR. B. T. A. BELL stated that Captain Adams had explained the objects of the meeting correctly. It had been called at the request of a large number of miners, amongst whom some dissatisfaction was prevalent respecting the existing methods of selling the product, both as regards prices and grades. With regard to prices it would be difficult to regulate them without the co-operation of every producer. Something would be accomplished by organization. A uniform standard of grading was eminently desirable and this, it seemed to him, could be easily determined by a conference of those interested in the production of the mineral.

MR. T. G. COURSOLLES.—If there is a way of coming to an understanding about prices so as not to undercut each other it would be a good thing, but the question of different kinds of mica comes up here. There is good mica and indifferent mica. Therefore, all mica cannot be sold at the same price even if we wanted to. If we were to establish an invariable rule for every kind of mica, then those who have mica of a poor quality might not be able to sell it at all, especially if the dealers and consumers were in the habit of getting first-class mica. Still there might be some way of coming to an arrangement about that. Men who produce large quantities may sell by the ton or carload, while others who do not produce so much have to sell by the few hundred pounds, and the man who contracts for 50 tons or 100 tons in a year can afford to sell it a little cheaper than the man with a few tons, because the only way the latter can get a return for his labor is to sell it trimmed or rough but graded, so that it might be found very difficult to determine upon a strict price list. We have sold hundreds of tons in the last three years, but latterly we have reduced our output on purpose because we found that we could make more money by reducing the output and selling in other ways. If you sell by wholesale necessarily the price must be lower than you sell by retail. If we sell to dealers who do not produce mica themselves we have to give them a reduction on the price. We have to protect the interests of the dealer, and there seems to be a price for the consumer and a price for the dealer.

MR. B. T. A. BELL said he could mention several instances where quantities of mica had been sold at suicidal prices, which did not begin to pay the cost of production.

MR. COURSOLLES.—Small miners or owners of lots who have found a few tons of mica will go to Montreal or elsewhere and sell it for whatever they can get, but they never sell much there, perhaps only a few tons.

MR. S. P. FRANCHOT.—As a dealer in mica he would say that that was the trouble. One never could tell what they were buying there were so many different grades. When I go to sell mica in the States I say to every party, "I will sell you 2x4 trimmed." Well, the next question is, "What do you mean by that?" Then again another mica man will offer 2x3, and 3x5, at a different price. There seems to be no proper method of grading. Now I hear that one man will sell 2x3 and 4x6 inclusive for $225 a ton, rough split, and that another will offer 1x3, and 4x6 for the same price. They are not worth the same price. The only way over the difficulty would be to sell 2x4 mica for so much money and 4x6 for so much money, and not guarantee anything larger than 4x6. I give those figures simply for illustration—you might make it 2x3 or 3x5. It has been stated to me in the States that they never would pay more than 60 cents for mica of any size, because if they had to pay more than that they would build up from small mica. Another will say that he does not use mica any more; that he uses brown paper.

MR. COURSOLLE.—It costs at least a dollar—they cannot do it for 60 cents.

MR. SEARS thought that a certain standard of grades should be decided upon. He thought the consumer of mica certainly knew what he bought—2x3 or 4x6. The Westinghouse Company in former days used brown paper and pasted scraps of mica on it, but they use nothing now but solid mica. They will not likely use brown paper again, and if they want big mica they should pay the price. The consumers are limited and they must have mica. They have not found anything to take the place of it yet and until they do they should pay the price for the big size.

CAPT. ADAMS.—Is micanite as effective as an insulator as the crude mica?

MR. COURSOLLES.—No; it is made up with shellac. It does very well for places where it does not come in contact with the electrical fluid. Lately we have had quite a demand for large mica and we sold some at from $1 to $1.50 a pound—n small orders, that is, 50 to 500 pounds.

CAPT. ADAMS enquired if the demand for small mica was found to be increasing.

MR. COURSOLLES said it has always been good and is increasing.

CAPT. ADAMS remarked that one of the difficulties seemed to be with the farmer and other small operators in selling at any price. A farmer has a little plot of ground out of which he takes half a ton. It is comparatively large for him and he is willing even to get half the market price, and it would seem to be a difficulty which the genuine mica miners have to confront—to prevent the price being established by those outside operators, men who only sell a little. He suggested that it might be well for the mica producers to sell through one channel. The basis would have to be a central company with capital enough to buy from each miner, then each man would have an interest in the thing.

MR. D. C. WATTERS thought that in order to establish a standard the best plan would be to determine the value of material as put through the Customs and build from that. No one seems quite sure what the discounts are and there is also discrepancy between the rough and trimmed material.

MR. FRANCHOT said that they should establish a price list and let the buyer in the States pay the duty. The price for duty is the price in Ottawa or Montreal, therefore it would behoove the producer to establish a price list in Canada.

MR. DAVIDSON suggested that the mica be divided into three grades—1x3 to 2x4, and 2x4 to 3x5 and 4x6.

MR. COURSOLLES stated that his company shipped without stating any grade but only sell 1x3 to 4x6 inclusive, or 2x3 to 4x6 inclusive, for which they asked a different price.

MR. POWELL said that if a grade be established and everyone sell at the same price the man who has the nicest mica is going to sell every time and the man with the dark mica or hard mica has to stand on the outside until they have disposed of their stock.

MR. BAUMGARTEN did not think that a standard price amongst mica men would hold for the simple reason that when there is a scarcity of money they will sacrifice their stuff and undercut each other. The only practical way was to have a sort of a pool and let each man contribute to the treasury, with which they could buy the mica, paying so much down and then afterwards dividing up *pro rata* the difference which the mica was sold for to the people in the States. If an association could be formed where men would put a little money into it, he would be willing to contribute so that a sort of combine might be formed to protect prices. He did not mean to stick people. The man hard by is not going to wait until he sees what his opponent is going to get. The small people are the first ones to ship mica at any price and that is the difficulty at present in matters of duty. His father informed him that the reason why the U. S. Customs enforce the highest price is because there is no standard price.

MR. DAVIDSON said the first thing was to establish a price in Canada in order to meet the Customs regulations in the States.

MR. WATTERS asked how they were going to determine upon the grade. If they fix the grade 1x3 and 2x4, and then 2x3 and 3x5, suppose a consumer wanted a grade of mica 2x3 and 2x4, would he have to pay the price of the nearest standard grade to what he wanted?

COL. WRIGHT believed that there was a necessity for a mica association. The producers have been cutting their own throats right along. If they had a standard price here there would be no trouble about the customs. Let the American buyers look after their own customs duties.

MR. FRANCHOT suggested that if an association be formed, it be a legally incorporated company with a certain amount of capital, so that if, say Mr. Coursolles has ten tons of mica to sell take it in at the market price, then turn round and sell to the consumer in the States, and at the end of the year when a balance is struck, divide the profits *pro rata* amongst the men who went into the pool.

MR. DAVIDSON.—All mica produced to be sold through the association—no sales made outside of it?

CAPT. Adams said that it seemed to him that the suggestion made to form a committee to consider the manner in which a mica association might be formed was a good one.

MR. BELL suggested that a small organization be formed, embracing every mica miner, without at first having any specific object other than the general interests of the mica trade, and from this they could go on from one thing to another, determining grades, &c. He moved, seconded by Mr. Coursolles, that such an association be formed, and that a preliminary committee be appointed to devise ways and means.

The following committee was then struck:— H. Bumgarten, (Canadian Mica Co., Ltd.); T. G. Coursolles, (Wallingford Mica Co.); B. T. A. Bell, (CANADIAN MINING REVIEW); W. Davidson, (Vavasour Association); D. C. Watters, (Lake Girard Mica System); W. F. Powell, (Clemow & Powell); S. P. Franchot, (Villeneuve Mica Mine; Lewis K. McLaurin, (McLaurin Bros.); and R. L. Blackburn, (Blackburn Mine.)

Moved by Mr. Bell, seconded by Mr. Franchot, that Mr. Davidson be appointed Secretary.—Carried.

A vote of thanks was unanimously passed to the Chairman, and to Mr. St. Jacques for the use of the room, and the meeting adjourned.

MEETING OF THE COMMITTEE.

A meeting of the committee was held at the Russell House on Wednesday, 27th November, when there were present: T. G. Coursolles, (Wallingford Mica Co.); Lewis K. McLaurin, (Blackburn Mine); G. S. Davison, (Vavasour Mining Association); H. Bumgarten, (Canadian Mica Co.); W. F. Powell, (Clemow and Powell.)

Mr. Coursolles was moved to the chatr, and after discussion, it was resolved "that the mica miners form a section to be known as the Mica Section of the General Mining Associotion of the Province of Quebec; that the section comprise all the producers and owners of mica property; and that the section be represented by a chairman, a secretary, and an executive committee of five."

It was decided to recommend for consideration at the next meeting of the section that the standard grade of mica rough split and edge trimmed be 1x3 to 2x4, 2x4 to 3x6, 3x6 to 4x7, and 4x7 up. These resolutions will be submitted at a general conference to be held in the Russell House, Ottawa, on 11th December next.

It was also decided to recommend that the selling price of all mica exported shall be based on the value of mica in Canada governed by grades.

The Rarer Metals and their Alloys.*

By Prof. W. Chandler-Roberts Austin, C.B., F.R.S.

The study of metals possesses an irresistable charm for us, quite apart from its vast national importance. How many of us made our first scientific experiment by watching the melting of lead, little thinking that we should hardly have done a bad life's work if the experiment had been our last, provided we had only understood its full significance. How few of us forget that we wistfully observed at an early age the melting in an ordinary fire of some metallic toy of our childhood; and such an experiment has, like the "Flat iron for a farthing," in Mrs. Ewing's charming story, taken a prominent place in literature which claims to be written for children. Hans Anderson's fairy tale, for instance, the "History of a Tin Soldier," has been read by children of all ages and of most nations. The romantic incidents of the soldier's eventful career need not be dwelt upon; but I may remind you that at its end he perished in the flames of an ordinary fire, and all that could subsequently be found of him was a small heart-shaped mass. There is no reason to doubt the perfect accuracy of the story recorded by Anderson, who at least knew the facts, though his statement is made in popular language. No analysis is given of the tin soldier; in a fairy tale it would have been out of place, but the latest stage of his evolution is described, and the record is sufficient to enable us to form the opinion that he was composed of both tin and lead, certain alloys of which metals will burn to ashes like tinder. His uniform was doubtless richly ornamented with gold lace. Some small amount of one of the rarer metals had probably—for on this point the history is silent—found its way into his constitution, and by uniting with the gold, formed the heart-shaped mass which the fire would not melt, as its temperature could not have exceeded 1060°C; for we are told that the golden rose, worn by the *artiste* who shared the soldier's fate, was also found unmelted. The main point is, however, that the presence of one of the rarer metals must have endowed the soldier with his singular endurance, and in the end left an incorruptible record of him.

This incident has been taken as the starting-point of the lecture, because we shall see that the ordinary metals so often owe remarkable qualities to the presence of a rarer metal which fits them for special work.

This early love of metals is implanted in us as part of our "unsquandered heritage of sentiments and ideals which has come down to us from other ages," but future generations of children will know far more than we did; for the attempt will be made to teach them that even psychology is a branch of molecular physics, and they will therefore see far more in the melted toy than a shapeless mass of tin and lead. It is really not an inert thing; for some time after it was newly cast, it was the scene of intense molecular activity. It probably is never molecularly quiescent, and a slight elevation of temperature will excite in it rapid atomic movement anew. The nature of such movement I have indicated on previous occasions when, as now, I have tried to interest you in certain properties of metals and alloys.

This evening I appeal incidentally to higher feelings than interest, by bringing before you certain phases in the life-history of metals which may lead you to a generous appreciation of the many excellent qualities they possess.

Metals have been sadly misunderstood. In the belief that animate beings are more interesting, experimenters have neglected metals, while no form of matter in which life can be recognized is thought to be too humble to receive encouragement. Thus it is that bacteria, with repulsive attributes and criminal instincts, are petted and watched with solicitude, and comprehensive schemes are submitted to the Royal Society for their development, culture, and even for their "education," (1) which may, it is true, ultimately make them useful metallurgical agents, as certain micro-organisms have already proved their ability to produce arseniuretted hydrogen from oxide of arsenic. (2)

It will not be difficult to show that methods which have proved so fruitful in results when applied to the study of living things, are singularly applicable to metals and alloys, which really present close analogies to living organisms. This must be a new view to many and it may be said, "it is well known that uneducated races tend to personify or animate external nature," and it is strange, therefore, to attempt, before a cultured audience, to trace analogies which must appear to be remote, between moving organisms and inert alloys, but "the greater the number of attributes that attach to anything, the more real that thing is."(3) Many of the less known metals are very real to me, and I want them to be so to you; listen to me, then, as speaking for my silent metallic friends, while I try to secure for them your sympathy and esteem.

First, as regards their origin and early history, I fully share Mr. Lockyer's belief as to their origin, and think that a future generation will speak of the evolution of metals as we now do of that of animals, and that observers will naturally turn to the sun as the field in which this evolution can best be studied.

To the alchemists metals were almost sentient; they treated them as if they were living beings, and had an elaborate pharmacopœia of "medicines" which they freely administered to metals in the hope of perfecting their constitutions. If the alchemists constantly drew parallels between living things and metals, it is not because they were ignorant, but because they recognized in metals the possession of attributes which closely resemble those of organisms. "The first alchemists were gnostics, and the old beliefs of Egypt blended with those of Chaldea in the second and third centuries. The old metals of the Egyptians represented men, and this is probably the origin of the *homunculus* of the middle ages, the notion of the creative power of metals and that of life being confounded in the same symbol. (4)

Thus Albertus Magnus traces the influence of congenital defects in the generation of metals and of animals, and Basil Valentine symbolizes the loss of metalline character, which we now know is due to oxidation, to the escape from the metal of an indestructible spirit which flies away and becomes a soul. On the other hand, the "reduction" of metals from their oxides was supposed to give the metals a new existence. A poem (5) of the thirteenth century well embodies this belief in the analogies between men and metals, in the quaint lines:

> "Homs ont l'estre comme metaulx,
> Vie et augment des vegetaulx,
> Instinct et sens comme les bruts,
> Espirit comme ange en attributs."

"Men have being"—constitution—like metals; you see how closely metals and life were connected in the minds of the alchemists, and we inherit their traditions.

"Who said these old renowns, dead long ago, could make me forget the living world?" are words which Browning places in the lips of Paracelsus, and we metallurgists are not likely to forget the living world; we borrow its definitions, and apply them to our metals. Thus nobility in metals as in men, means freedom from liability to tarnish, and we know that the rarer metals are like rarer virtues, and have singular power in enduing their more ordinary associates with firmness, elasticity, strength and endurance. On the other hand, some of the less known metals appear to be mere "things" which do not exist for themselves, but only for the sake of other metals to which they can be united. This may, however, only seem to be the case because we, as yet, know so little about them. The question naturally arises, how can the analogies between organic and inorganic bodies now be traced? I agree with my colleague at the Ecole des Mines of Paris, Prof. Urbain Le Verrier, in thinking that it is possible (6) to study the biology, the anatomy, and even the pathology of metals.

The anatomy of metals—that is, their structure and framework—is best examined by the aid of the microscope, but if we wish to study the biology and pathology of metals, the method of autographic pyrometry, which I brought before you in a Friday evening lecture, delivered in 1892, will render admirable service, for, just as in biological and pathological phenomena vital functions and changes of tissue are accompanied by a rise or fall in temperature, so molecular changes in metals are attended with an evolution or absorption of heat. With the aid of the recording pyrometer we now "take the temperature" of a mass of metal or alloy in which molecular disturbance is suspected to lurk, as surely as a doctor does that of a patient in whom febrile symptoms are manifest.

It has, moreover, long been known that we can submit a metal or an alloy in its normal state to severe stress, record its power of endurance, and then, by allowing it to recover from fatigue, enable it to regain some, at least, of its original strength. The human analogies of metals are really very close indeed, for, as is in the case with our own mental efforts, the internal molecular work which is done in metals often strengthens and invigorates them. Certain metals have a double existence, and, according to circumstances, their behavior may be absolutely harmful or entirely beneficial. The dualism we so often recognize in human life becomes allotropism in metals, and they, strangely enough, seem to be restricted, to a single form of existence if they are absolutely free from contamination for probably an absolutely pure metal cannot pass from a normal to an allotropic state. Last, it may be claimed that some metals possess attributes which are closely allied to moral qualities, for, in their relations with other elements, they often display an amount of discrimination and restraint that would do credit to sentient beings.

Close as this resemblance is, I am far from attributing consciousness to metals, as their atomic changes result from the action of external agents, while the conduct of conscious beings is not determined from without, but from within. I have, however, ventured to offer the introduction of this lecture in its present form, because any facts which lead us to reflect on the unity of plan in nature, will aid the recognition of the complexity of atomic motion in metals upon which it is needful to insist.

The foregoing remarks have special significance in relation to the influence exerted by the rarer metals on the ordinary ones. With exception of the action of carbon upon iron, probably nothing is more remarkable than the action of the rare metals on those which are more common; but their peculiar influence often involves, as we shall see, the presence of carbon in the alloy.

Which, then, are the rarer metals, and how may they be isolated? The chemist differs somewhat from the metallurgist as to the application of the word "rare." The chemist thinks of the "rarity" of a compound of a metal; the metallurgist, rather of the difficulty of isolating the metal from the state of combination in which it occurs in nature.

The chemist, in speaking of the reactions of salts of the rarer metals, in view of the wide distribution of limestone and pyrolusite, would hardly think of either calcium or manganese as being among the rarer metals. The metallurgist would consider pure calcium or pure manganese to be very rare. I have only recently seen comparatively pure specimens of the latter.

The metals which, for the purposes of this lecture, may be included among the rarer metals are: (1) those of the platinum group, which occur in nature in the metallic state; and (2) certain metals which in nature are usually found as oxides or in an oxidized form of some kind, and these are chromium, manganese, vanadium, tungsten, titanium, zirconium, uranium, molybdenum (which occurs, however, as sulphide). Incidental reference will be made to nickel and cobalt.

Of the rare metals of the platinum group I propose to say but little; we are indebted for a magnificent display of them in the library to my friends, Messrs. George and Edward Matthey, and to Mr. Sellon, all members of a great firm of metallurgists. You should specially look at the splendid mass of palladium, extracted from native gold of the value of £2,500,000, at the melted and rolled iridium, and at the masses of osmium and rhodium. No other nation in the world could show such specimens as these, and we are justly proud of them.

These metals are so interesting and precious in themselves that I hope you will not think I am taking a sordid view of them by saying that the contents of the case exhibited in the library are certainly not worth less than ten thousand pounds.

As regards the rarer metals which are associated with oxygen, the problem is to remove the oxygen, and this is usually effected either by affording the oxygen an

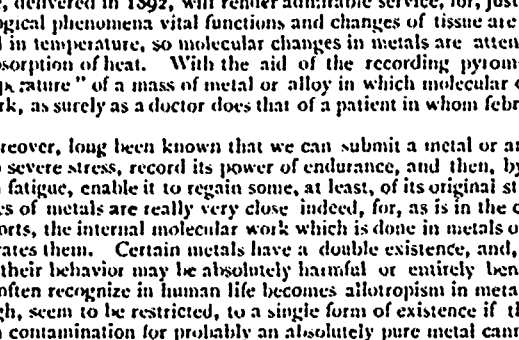

Fig. 1.

opportunity for uniting with another metal, or by reducing the oxide of the rare metal by carbon, aided by the tearing effect of an electric current. In this crucible there is an intimate mixture, in atomic proportions, of oxide of chromium and finest divided metallic aluminium. The thermo-junction (A, Fig. 1) of the pyrometer which formed the subject of my last Friday evening lecture here, is placed within the crucible, B, and the spot of light, C, from the galvanometer, D, with which the junction is connected, indicates on the screen that the temperature is rising. You will observe that, as soon as the point marked 1010° is reached, energetic action takes place; the

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*A Lecture delivered on March 15, 1895, before the members of the Royal Institution.

(1) Dr. Percy Frankland specially refers to the "education" of bacilli for adapting them to altered conditions. Roy. Soc. Proc. Vol. LVI., '94, p. 539.

(2) Dr. Brauner, Chem. News, Feb. 15, 1895, p. 79.

(3) Lotze, "Metaphysic," 46, quoted by Illingworth. "Personality, Human and Divine." Bampton Lectures, 1894, p. 43.

(4) Berthelot, Les Origines de l'Alchimie, 1885, p. 60.

(5) Les Remontrances ou la complainte de nature a l'Alchymiste errant. Attributed to Jehan de Meung, who with Guillaume de Lorris wrote the Roman de la Rose. M. Meon, the editor of the edition of 1814 of this celebrated work, doubts, however, whether the attribution of the Complainte de Nature to Meung is correct.

(6) "La Metallurgie en France," 1894, p. 2.

temperature suddenly rising above the melting point of platinum, melts the thermo junction, and the spot of light swings violently; but if the crucible be broken open, you will see that a mass of metallic chromium has been liberated.

The use of alkaline metals in separating oxygen from other metels is well known. I cannot enter into its history here, beyond saying that if I were to do so, frequent reference to the honored names of Berzelius, Wohler and Winkler would be demanded. (7)

Mr. Vautin has recently shown that granulated aluminium may readily be prepared, and that it renders great service when employed as a reducing agent. He has lent me many specimens of rarer metals which have been reduced to the metallic state by the aid of this finely-granulated aluminium; and I am indebted to his assistant, Mr. Picard, who was lately one of my own students at the Royal School of Mines, for aid in the preparation of certain other specimens which have been isolated in my laboratory at the mint.

The experiment you have just seen enables me to justify a statement I made respecting the discriminating action which certain metals appear to exert. The relation of aluminium to other metals is very singular. When, for instance, a small quantity of aluminium is present in cast-iron, it protects the silicon, manganese and carbon from oxidation. (8) The presence of silicon in aluminium greatly adds to the brilliancy with which aluminium itself oxidizes and burns. (9) It is also asserted that aluminium, even in small quantity, exerts a powerful protective action against the oxidation of the silver-zinc alloy which is the result of the desilverisation of lead by zinc.

Moreover, heat aluminium in mass to redness in air, where oxygen may be had freely, and a film of oxide which is formed will protect the mass from further oxidation. On the other hand, if finely divided aluminium finds itself in the presence of an oxide of a rare metal, at an elevated temperature, it at once acts with energy and promptitude, and releases the rare metal from the bondage of oxidation. I trust, therefore, you will consider my claim that a metal may possess moral attributes has been justified. Aluminium, moreover, retains the oxygen it has acquired with great fidelity, and will only part with it again at very high temperatures, under the influence of the electric arc in the presence of carbon.

(A suitable mixture of red-lead and aluminium was placed in a small crucible heated in a wind-furnace, and in two minutes an explosion announced the termination of the experiment. The crucible was shattered to fragments.)

The aluminium loudly protests, as it were, against being entrusted with such an easy task, as the heat engendered by its oxidation had not to be used in melting a difficultly fusible metal like chromium, the melting point of which is higher than that of platinum.

It is admitted that a metal will abstract oxygen from another metal: the reaction is more exothermic than that by which the oxide to be decomposed was originally formed. The heat of formation of alumina is 391 calories, that of oxide of lead is 51 calories: so that it might be expected that metallic aluminium, at an elevated temperature, would readily reduce oxide of lead to the metallic state.

The last experiment, however, proved that the reduction of oxide of lead by aluminium is effected with explosive violence, the temperature engendered by the reduction being sufficiently high to volatilize the lead. Experiments of my own show that the explosion takes place with much disruptive power when aluminium reacts on oxide of lead *in vacuo*, and that if coarsely ground, fused litharge be substituted for red lead, the action is only accompanied by a rushing sound. The result is, therefore, much influenced by the rapidity with which the reaction can be transmitted throughout the mass. It is this kind of experiment which makes us turn with such vivid interest to the teaching of the school of St. Claire Deville, the members of which have rendered such splendid services to physics and metallurgy. They do not advocate the employment of the mechanism of molecules and atoms in dealing with chemical problems, but would simply accumulate evidence as to the physical circumstances under which chemical combination and dissociation take place, viewing these as belonging to the same class of phenomena as solidification, fusion, condensation, and evaporation. They do not even insist upon the view that matter is minutely granular, but in all cases of change of state, make calculations on the basis of work done, viewing changed "internal energy" as a quantity which should reappear when the system returns to the initial state.

A verse, of some historical interest, may appeal to them. It occurs in an old poem to which I have already referred as being connected with the *Roman de la Rose*, and it expresses nature's protest against those who attempt to imitate her works by the use of mechanical methods. The "argument" runs thus: –

" Comme Nature se complaint,
Et dit sa douleur et son plaint
A ung sot souffleur sophistique
Qui n' use que d'art mechanique."

If the "use of mechanical art" includes the study of chemistry on the basis of the mechanics of the atoms, I may be permitted to offer the modern school the following rendering of nature's plaint: –

How nature sighs without restraint,
And grieving makes her sad complaint
Against the subtle sophistry
Which trusts atomic theory.

An explosion such as is produced when aluminium and oxide of lead are heated in presence of each other, which suggested the reference to the old French verse, does not often occur, as in most cases the reduction of the rarer metals by aluminium is effected quietly.

Zirconium is a metal which may be so reduced. I have in this way prepared small quantities of zirconium from its oxide, and have formed a greenish alloy of extraordinary strength by the addition of 2-10 per cent. of it to gold, and there are many circumstances which lead to the belief that the future of zirconium will be brilliant and useful. I have reduced vanadium and uranium from its oxide by means of alumiaium as well as manganese, which is easy, and titanium, which is more difficult. Tungsten, in fine specimens, is also before you—and allusion will be made subsequently to the uses of these metals. At present I would draw your attention to some properties of titanium which are of special interest. It burns with brilliant sparks in air; and as few of us have seen titanium burn, it may be well to burn a little in this flame. (Experiment performed.) Titanium appears to be, from the recent experiments of M. Moissan, the most difficultly fusible metal known; but it has the singular property of burning in nitrogen, it presents, in fact, the only known instance of vivid combustion in nitrogen. (10)

Titanium may be readily reduced from its oxide by the aid of aluminium. Here are considerable masses, sufficiently pure for many purposes, which I have recently prepared in view of this lecture.

The other method by which the rarer metals may be isolated is that which involves the use of the electrical furnace. In this connection the name of Sir W. Siemens should not be forgotten. He described the use of the electric arc-furnace in which the carbons were arranged vertically, the lower carbon being replaced by a carbon crucible, and in 1882 he melted in such a furnace no less than ten pounds of platinum during an experiment at which I had the good fortune to assist. It may fairly be claimed that the large furnaces with a vertical carbon in which aluminium and other metals are now reduced by the combined electrolytic action and tearing temperature of the arc, are the direct outcome of the work of Siemens.

In the development of the use of the electric arc for the isolation of the rare, difficultly fusible metals, Moissan stands in the front rank. He points out (Ann. de Chim et de Phys., vol. iv., 1895, p. 365) that Despretz (Comptes Rendus, vol. xxviii, p. 755, and vol. xxix, 1849, pp. 48, 545, 712) used in 1849, the heat produced by the arc of a powerful pile but Moissan was the first to employ the arc in such a way as to separate its heating effect from the electrolytic action it exerts. This he does by placing the poles in a horizontal position, and by reflecting their heat into a receptacle below them. He has shown in a series of classical researches that employing 800 amperes and 110 volts a temperatnre of at least 3,500 degrees may be attained, and that many metallic oxides which until recently were supposed to be irreducible may be readily made to yield the metal they contain. (The principal memoirs of M. Moissan will be found in the Comptes Rendus, vol. cxv., 1892, p. 1031; ibid. vol cxvi., 1893, pp. 347, 549, 1222, 1225, 1429; ibid. vol. cxix., 1894, pp. 15, 20, 935; ibid., vol. cxx., 1895, p. 290. The more important of the metals he has isolated are uranium, chromium, manganese, zirconium, molybdenum, tungsten, vanadium and titanium. There is an important paper by him on the various forms of the electric furnace in the Ann. de Chim. et de Phys. vol. iv., 1895, p. 365.

A support or base for the metal to be reduced is needed, and this is afforded by magnesia, which appears to be absolutely stable at the utmost temperatures of the arc. An atmosphere of hydrogen may be employed to avoid oxidation of the reduced metal, which, if it is not a volatile one, remains at the bottom of the crucible almost always associated with carbon—forming, in fact, a carbide of the metal. I want to show you the way in which the electric furnace is used, but unfortunately the reductions are usually very tedious, and it would be impossible to actually show you much if I were to attempt to reduce before you any of the rarer metals; but as the main object is to

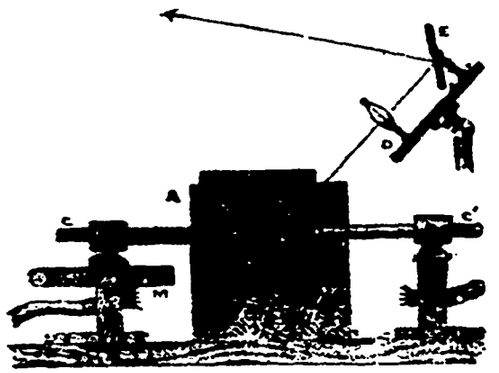

FIG. 2.

show you how the furnace is used, it may be well to boil some silver at a temperature of some 2500°, and subsequently to melt chromium in the furnace (Fig. 2). This furnace consists of a clay receptacle, A, lined with magnesia, B. A current of 60 amperes and 100 volts is introduced by the carbon poles, C, C; an electro-magnet, M, is provided to deflect the arc on to the metal to be melted. (By means of a lens and mirror, D, E, the image of the arc and of the molten metal was projected on to a screen. For this purpose it was found convenient to make the furnace much deeper than would ordinarily be the case.)

The result is very beautiful, but can only be rendered in dull tones by the accompanying illustrations (Figs. A B.) It may be well, therefore, to state briefly what is seen when the furnace is arranged for the melting of metallic chromium. Directly the current is passed, the picture reflected by the mirror, E, Fig. 2, shows the interior of the furnace (Fig. A) as a dark crater, the dull red poles revealing the metallic lustre and grey shadows of the metal beneath them. A little later these poles become tipped with dazzling white, and, in the course of a few minutes, the temperature rises to about 2500° C. Such a temperature will keep chromium well melted, though a thousand degrees more may readily be attained in a furnace of this kind. Each pole is soon surrounded with a lambent halo of the green-blue hue of the sunset, the central band of the arc changing rapidly from peach-blossom to lavender and purple. The

Fig. A—This represents the interior of the furnace containing molten chromium as is seen either by reflection on a screen or by looking into the furnace from above, the eyes being suitably protected by deeply tinted glasses.

(7) An interesting paper, by H. F. Keller, on the reduction of oxides of metals by other metals, will be found in the *Journal* of the American Chemical Society, December, 1894, page 533.

(8) Bull. Soc. Chim Paris, vol. xi. 1894, p. 377.

(9) "Ditte Leçons sur les Metaux," part ii. 1891, p. 206.

(10) Lord Rayleigh has since stated that titanium does not combine with argon: and M. Guntz points out that lithium in combining with nitrogen produces incandescence. M. Moisson has also shown that uranium does not absorb argon.

Fig. B—In this case the arc was broken the instant before the photograph was taken. The furnace contained a bath of silver just at its boiling point. The reflection of the poles in the bath, the globules of distilled silver, and the drifting cloud of silver vapour, are well shown.

arc can then be lengthened, and as the poles are drawn farther and farther asunder, the irregular masses of chromium fuse in silver droplets, below an intense blue field of light, passing into green of lustrous emerald; then the last fragments of chromium melt into a shining lake, which reflects the glowing poles in a glory of green and gold, shot with orange hues. Still a few minutes later, as the chromium burns, a shower of brilliant sparks of metal are projected from the furnace, amid the clouds of russet or brown vapours which wreath the little crater; whilst if the current is broken, and the light dies out, you wish that Turner had painted the limpid tints, and that Ruskin might describe their loveliness.

The effect when either tungsten or silver (Fig. B) replaces chromium is much the same, but, in the latter case, the glowing lake is more brilliant in its turbulent boiling, and blue vapours rise to be condensed in the iridescent beads of distilled silver which stud the crater walls.

Such experiments will probably lend a new interest to the use of the arc in connection with astronomical metallurgy, for, as George Herbert said long ago:

"Stars have their storms even in a high degree,
As well as we";

and Lockyer has shown how important it is, in relation to such storms, to be able to study the disturbance in the various strata of the stellar or solar atmosphere. Layers of metallic vapour which differ widely in temperature can be more readily obtained by the use of the electrical furnace than when a fragment of metal is melted and volatilised by placing it in the arc on the lower carbon.

It must not be forgotten that the use of the electric arc between carbon poles renders it practically impossible to prepare the rare metals without associating them with carbon, often forming true carbides; but it is possible in many cases to separate the carbon by subsequent treatment. Moissan has, however, opened up a vast field of industrial work by placing at our disposal practically all the rarer infusible metals which may be reduced from oxides, and it is necessary for us now to consider how we may best enter upon our inheritance. Those members of the group which we have known long enough to appreciate are chromium and manganese, and these we have only known free from carbon for a few months. In their carburised state they have done excellent service in connection with the metallurgy of steel; and may we not hope that vanadium, molybdenum, titanium, and uranium will render still greater services. My object in this lecture is mainly to introduce you to these metals, which hitherto few of us have ever seen except as minute cabinet specimens, and we are greatly indebted to Mr. Moissan for sending us beautiful specimens of chromium, vanadium, uranium, zirconium, tungsten, molybdenum, and titanium. (These were exhibited.)

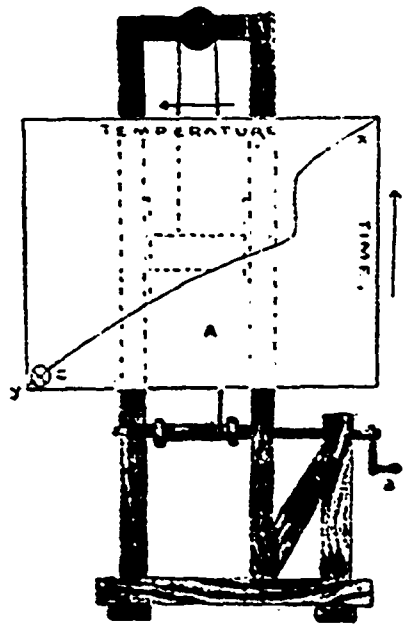

Fig. 3.

The question naturally arises: Why is the future of their usefullness so promising? Why are they likely to render better service than the common metals with which we have long been familiar? It must be confessed that as yet we know but little what services these metals will render when they stand alone; we have yet to obtain them in a state of purity, and have yet to study their properties, but when small quantities of any of them are associated or alloyed with other metals, there is good reason to believe that they will exert a very powerful influence. In order to explain this, I must appeal to the physical method of inquiry to which I have already referred.

It is easy to test the strength of a metal or of an alloy; it is also easy to determine its electrical resistance. If the mass stands these tests well, its suitability for certain purposes is assured; but a subtle method of investigation has been afforded by the results of a research entrusted to me by a committee of the Institution of Mechanical Engineers, over which Dr. Anderson, of Woolwich, presides. We can now gather much information as to the way in which a mass of metal has arranged itself during the cooling from a molten condition, which is the necessary step in fashioning it into a useful form; it is possible to gain insight into the way in which a molten mass of a metal or an alloy molecularly settles itself down to its work, so to speak, and we can form conclusions as to its probable sphere of usefulness.

The method is a graphic one, such as this audience is familiar with, for Prof. Victor Horsley has shown in a masterly way that traces on smoked paper may form the record of the heart's action under the disturbing influence caused by the intrusion of a bullet into the human body. I hope to show you by similar records the effect, which though disturbing is often far from prejudicial, of the introduction of a small quantity of a foreign element into the "system" of a metal, and to justify a statement which I made earlier, as to the applicability of physiological methods of investigation to the study of metals. In order that the nature of this method may be clear, it must

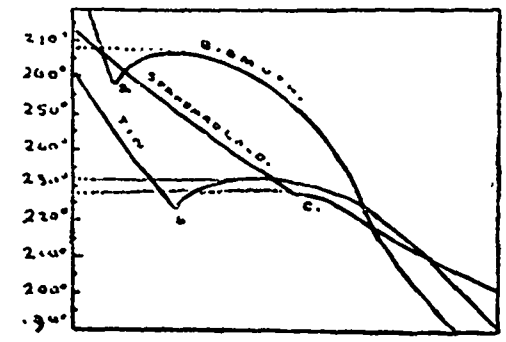

Fig. 4.

be remembered that if a thermometer or a pyrometer, as the case may be, is plunged into a mass of water or of molten metal, the temperature will fall continuously until the water or the metal begins to become solid; the temperature will then remain constant until the whole mass is solid, when the downward course of the temperature is resumed. This little thermo-junction is plunged into a mass of gold; an electric current is, in popular language, generated, and the strength of the current is proportional to the temperature to which the thermo-junction is raised; so that the spot of light from a galvanometer to which the thermo-junction is attached enables us to measure any thermal changes that may occur in a heated mass of metal or alloy.

It is only necessary for our purpose to use a portion of the long scale and to make that portion of the scale movable. Let me try to trace before you the curve of the freezing of pure gold. It will be necessary to mark the position occupied by the movable spot of light at regular intervals of time during which the gold is near 1045°C.—that is, while the metal is becoming solid. Every time a metronome beats a second, the white screen A (Fig. 3), a sheet of paper will be raised a definite number of inches by the gearing and handle, B, and the position successively occupied by the spot of light, C, will be marked by hand.

You see that the time-temperature curve, x, y, so traced is not continuous. The freezing-point of the metal is very clearly marked by the vertical portion. If the gold is very pure the angles are sharp, if it is impure they are rounded. If the metal had fallen below its freezing point without actually becoming solid, that is, if supersfusion or surfusion had occurred, then there would be, as is often the case, a dip where the freezing begins, and then the temperature curve rises suddenly.

If the metal is alloyed with large quantities of other metals, then there may be several of these freezing points, as successive groups of alloys fall out of solution. The rough diagrammatic method is not sufficiently delicate to enable me to trace the subordinate points, but they are of vital importance to the strength of the metal or alloy, and photography enables us to detect them readily.

Take the case of the tin-copper series; you will see that as a mass of tin-copper alloy cools, there are at least two distinct freezing points. At the upper one the main mass of the fluid alloy became solid; at the lower, some definite group of tin and copper atoms fall out, the position of the lower point depending upon the composition of the mass.

Now turn to more complex curves taken on one plate by making the sensitised photographic plate seize the critical part of the curve, the range of the swing of the mirror from hot to cold being some sixty feet. The upper curve (Fig. 4) gives the freezing point of bismuth, and you see that surfusion, a, is clearly marked, the temperature at which bismuth freezes being 268°C. The lower curve marked "tin," represents the freezing point of that metal, which we know is 231°C, and in its surfusion, B, is also clearly marked. The curve marked standard gold contains a subordinate point, C, which you will observe is lower than the freezing point of tin, and it is caused by the solidification of a small portion of bismuth, which alloyed itself with some gold atoms, and remained fluid below the freezing point not only of bismuth itself but of tin. Now gold with a low freezing point in it like this is found to be very brittle, and we are in a fair way to answer the question why $\frac{1}{10}$ per cent. of zirconium doubles the strength of gold, while $\frac{1}{20}$ per cent. of thallium, another rare metal, halves the strength. In the case of the zirconium the subordinate point is very high up, while in the case of the thallium it is very low down. So far as my experiments have as yet been carried, this seems to be a fact which underlies the whole question of the strength of metals and alloys. If the subordinate point is low, the metal will be weak: if it is high in relation to the main setting point, then the metal will be strong, and the conclusion of the whole matter is this:— The rarer metals which demand for their isolation from their oxides either the use of aluminium or the electric arc, never, so far as I can ascertain, produce low freezing points when they are added in small quantities to those metals which are used for constructive purposes. The difficultly fusible rarer metals are never the cause of weakness, but always confer some property which is precious in industrial use. How these rarer metals act, why the small quantities of the added rare metals permeate the molecules, or, it may be the atoms, and strengthen the metallic mass, we do not know; we are only gradually accumulating evidence which is afforded by this very delicate physiological method of investigation.

As regards the actual temperatures represented by points on such curves, it will be remembered that the indications afforded by the recording pyrometer are only relative, and that gold is one of the most suitable metals for enabling a high, fixed point to be determined. There is much trustworthy evidence in favor of the adoption of 1045° as the melting point hitherto accepted for gold. The results of recent work indicate, however, that this is too low, and it may prove to be as high as 1061·7, which is the melting point given by Heycock and Neville* in the latest of their admirable series of investigations to which reference was made in my Friday evening lecture of 1892.

It may be well to point to a few instances in which the industrial use of such of the rarer metals, as have been available in sufficient quantity, is made evident. Modern developments in armour-plate and projectiles will occur to many of us at once. This diagram (Fig. 5) affords a rapid view of the progress which has been made, and in collecting the materials for it from various sources, I have been aided by Mr. Jenkins. The effect of projectiles of approximately the same weight, when fired with the same velocity against six-inch plates, enables comparative results to be studied, and illustrates the fact that the rivalry between artillerists who design guns, and metallurgists who attempt to produce both impenetrable armour-plates and irresistible projectiles, forms one of the most interesting pages in our national history. When metallic armour was first applied to the sides of war vessels, it was of wrought iron, and proved to be of very great service by absolutely preventing the passage of ordinary cast-iron shot into the interior of the vessel, as was demonstrated during the American civil war in 1866. It was found to be necessary, in order to pierce the plates, to employ harder and larger projectiles than those then in use, and the chilled cast-iron shot with which Colonel Palliser's name is identified proved to be formidable and effective. The point of such a projectile was sufficiently hard to retain its form under impact with the plate, and it was only necessary to impart a moderate velocity to a shot to enable it to pass through the wrought-iron armour (Fig. 5).

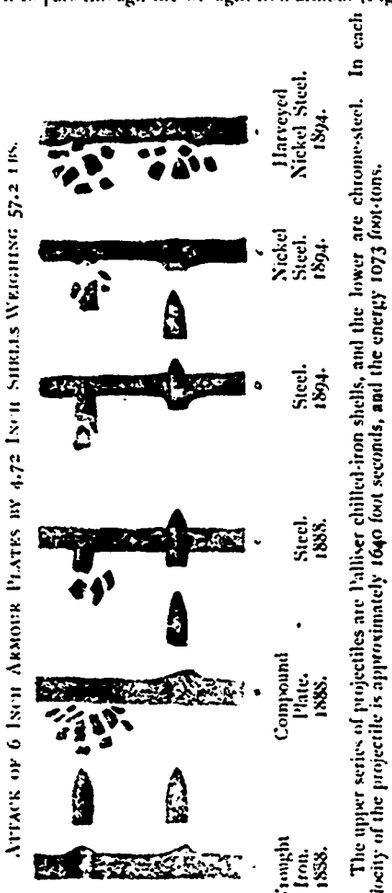

Fig. 5. The upper series of projectiles are Palliser chilled-iron shells, and the lower are chrome-steel. In each case the velocity of the projectile is approximately 1640 foot seconds, and the energy 1073 foot-tons.

It soon became evident that in order to resist the attack of such projectiles with a plate of any reasonable thickness, it would be necessary to make the plate harder, so that the point of the projectile should be damaged at the moment of first contact, and the reaction to the blow distributed over a considerable area of the plate. This object could be attained by either using a steel plate in a more or less hardened condition, or by employing a plate with a very hard face of steel, and a less hard but tougher back. The authorities in this country during the decade, 1880-90, had a very high opinion of plates that resisted attack without the development of through cracks, and this led to the production of the compound plate. The backs of these plates (B, Fig. 5) are of wrought iron, the fronts are of a more or less hard variety of steel, either cast on, or welded on by a layer of steel of an intermediate quality cast between the two plates. Armour-plates of this kind differ in detail, but the principle of their construction is now generally accepted as correct.

Such plates shown by plate B, resisted the attack of large Palliser shells admirably, as when such shells struck the plate they were damaged at their points, and the remainder of the shell was unable to perforate the armour against which it was directed. An increase in the size of the projectiles led, however, to a decrease in the resisting power of the plates, portions of the hard face of which would at times be detached in flakes from the junction of the steel and the iron. An increase in the toughness of the projectiles by a substitution of forged chrome-steel for chilled iron (see lower part of plate B), secured a victory for the shot, which was then enabled to impart its energy to the plate faster than the surface of the plate itself could transmit the energy to the back. The result was that the plate was overcome, as it were, piecemeal; the steel surface was not sufficient to resist the blow itself, and was shattered, leaving the projectile an easy victory over the soft back. The lower part of plate B, (in Fig. 5), represents a similar plate to that used in the Nettle trials of 1888. (11) It must not be forgotten in this connection, that the armour of a ship is but little likely to be struck twice by heavy projectiles in the same place, although it might be by smaller ones.

Plates made entirely of steel, on the other hand, were found, prior to 1888, to have a considerable tendency to break up completely when struck by the shot. It was not possible on that account, to make their faces as hard as those of compound plates; but while they did not resist the Palliser shot nearly so well as the rival compound plate, they offered more effective resistance to steel shot (see lower part of plate C, Fig. 5).

It appears that Berthier recognized in 1820, the great value of chromium when alloyed with iron; but its use for projectiles, although now general, is of comparatively recent date, and these projectiles now commonly contain from 1.2 to 1.5 per cent. of chromium, and will hold together even when they strike steel plates at a velocity of 2,000 ft. per second (12) (see lower part of plate D); and unless the armour plate is of considerable thickness, such projectiles will even carry bursting charges of explosives through it. (The behaviour of a chromium steel shell, made by Mr. Hadfield, was dwelt upon, and the shell was exhibited.)

It now remained to be seen what could be done in the way of toughening and hardening the plates so as to resist the chrome-steel shot. About the year 1888, very great improvements were made in the production of steel plates. Devices for hardening and tempering plates were ultimately obtained, so that the latter were hard enough throughout their substance to give them the necessary resisting power without such serious cracking as had occurred in previous ones. But in 1889 Mr. Riley exhibited at the meeting of the Iron and Steel Institute a thin plate that owed its remarkable toughness to the presence of nickel in the steel. The immediate result of this was that plates could be made to contain more carbon, and hence be harder, without at the same time having increased brittleness; such plates, indeed, could be water hardened and yet not crack.

The plate E (Fig. 5), represents the behaviour of nickel-steel armour. It will be seen that it is penetrated to a much less extent than in the former case; at the same time there is entire absence of cracking.

Now, as to the hardening processes. Evrard had developed the use of the lead bath in France, while Captain Tressider (Weaver, "Notes on Armour," Journal U. S. Artillery, Vol. III, 1894, p. 417), had perfected the use of the water-jet in England for the purpose of rapidly cooling the heated plates. The principle adopted in the design of the compound plates has been again utilized by Harvey, who places the soft steel or nickel-steel plate in a furnace of suitable construction, and covers it with carbonaceous material such as charcoal, and strongly heats it for a period, which may be as long as 120 hours. This is the old Sheffield process of cementation, and the result is to increase the carbon from 0.25 per cent. in the body of the plate to 0.6 per cent., or even more at the front surface, the increase in the amount of carbon only extending to a depth of two or three inches in the thickest armour.

The carburized face is then "chill-hardened," the result being that the best chrome-steel shot are shattered at the moment of impact, unless they are of very large size as compared with the thickness of the plate. The interesting result was observed lately ("Brassey's Naval Annual," 1894, p. 367) of shot doing less harm to the plate and penetrating less when its velocity was increased beyond a certain value, a result due to a superiority in the power of the face of the plate to transmit energy over that possessed by the projectile, which was itself damaged, when a certain rate was exceeded. At a comparatively low velocity the point of the shot would resist fracture, but the energy of the projectile is not then sufficient to perforate the plate, which would need the attack of a much larger gun firing projectile at a lower velocity.

The tendency today is to dispense with nickel, and to use ordinary steel, "Harveyed"; (Engineering, Vol. LVII. 1894, pp. 465, 530, 595), this gives excellent six-inch plates, but there is some difference of opinion as to whether it is advantageous to omit nickel in the case of very thick plates, and the problem is now being worked out by the method of trial. Probably, too, the Harveyed plates will be much improved by judicious forging after the process, as is indicated by some recent work done in America. The use of chromium in the plates may lead to interesting results.

Turn for a moment to the *Majestic* class of ships, the construction of which we owe to the genius of Sir William White, to whom I am indebted for a section representing the exact size of the protection afforded to the carbette of the *Majestic*. (This section was exhibited and is shown as reduced to the diagram Fig. 6.) Her armor is of the Harveyed steel, which has hitherto proved singularly resisting to chromium projectiles.

In this section, A represents a 14-inch Harveyed steel armor plate; B, a 4-inch teak backing; C, a 1¼-inch steel plate; D, ½-inch steel frames; and E, ½-inch steel linings.

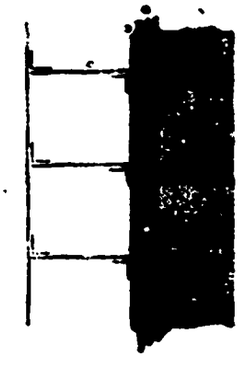

Fig. 6—Section of the barbette of the Majestic.

It will, I trust, have been evident that two of the rarer metals, chromium and nickel, are playing a very important part in our national defences; and if I ever lecture to you again, it may be possible for me to record similar triumphs for molybdenum, titanium, vanadium, and others of these still rarer metals.

Here is another alloy, for which I am indebted to Mr. Hadfield. It is iron alloyed with 25 per cent. of nickel, and Hopkinson has shown that its density is permanently reduced by two per cent. by an exposure to a temperature of 30°—that is, the metal expands at this temperature.

*"Trans. Chem. Soc.," Vol. LXVII, 1895, p. 160.

(11) Proceedings, Institution of Civil Engineers, 1889, Vol. XCVIII, p. 1, et. seq.
(12) Journal U. S. Artillery, 1893, Vol. II, p. 497.

Supposing, therefore, that a ship-of-war was built in our climate of ordinary steel, and clad with some three thousand tons of such nickel-steel armor, we are confronted with the extraordinary fact that if such a ship visited the Arctic regions, it would actually become some two feet longer, and the shearing which would result from the expansion of the armor by exposure to cold would destroy the ship. Before I leave the question of the nickel-iron alloys, let me direct your attention to this triple alloy of iron, nickel, and cobalt in simple atomic proportions. Dr. Oliver Lodge believes that this alloy will be found to possess very remarkable properties; in fact, as he told me, if nature had properly understood Mendeleef, this alloy would really have been an element. As regards the electrical properties of alloys, it is impossible to say what services the rarer metals may not render; and I would remind you that "platinoid," mainly a nickel-copper alloy, owes to the presence of a little tungsten its peculiar property of having a high electrical resistance which does not change with temperature.

One other instance of the kind of influence the rarer metals may be expected to exert is all that time will permit me to give you. It relates to their influence on

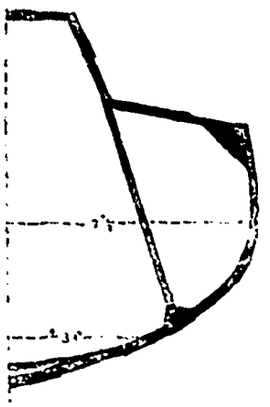

Fig. 7—Half Section Midship of Aluminium Torpedo Boat.

aluminium itself. You have heard much of the adoption of aluminium in such branches of naval construction as demand lightness and portability. During last autumn, Messrs. Yarrow completed a torpedo-boat which was built of aluminium alloyed with 6 per cent. of copper. Her hull is 50 per cent. lighter, and she is 3½ knots faster than a similar boat of steel would have been, and, notwithstanding her increased speed, is singularly free from vibration.

Her plates are ⅛-inch thick, and ¼-inch where greater strength is needed. It remains to be seen whether copper is the best metal to alloy with aluminium. Several of the rarer metals have already been tried, and among them titanium. Two per cent. of this rare metal seems to confer remarkable properties on aluminium, and it should do so according to the views I have expressed, for the cooling curve of the titanium-aluminium alloy would certainly show a high subordinate freezing point.

Hitherto I have appealed to industrial work, rather than to abstract science, for illustrations of the services which the rarer metals may render. One reason for this is that at present we have but little knowledge of some of the rarer metals apart from their association with carbon. The metals yielded by treatment of oxides in the electric arc are always carburized. There are, in fact, some of the rarer metals which we, as yet, can hardly be said to know except as carbides. As the following experiment is the last of the series, I would express my thanks to my assistant, Mr. Stansfield, for the great care he has bestowed in order to ensure their success. Here is the carbide of calcium which is produced by heating lime and carbon in the electric arc. It possesses great chemical activity, for if it is placed in water the calcium seizes the oxygen of the water, while the carbon also combines with the hydrogen, and acetylene is the result, which burns brilliantly. (Experiments shown.) If the carbide of calcium be placed in chlorine water, evil smelling chloride of carbon is formed.

In studying the relations of the rarer metals to iron, it is impossible to dissociate them from the influence exerted by the simultaneous presence of carbon; but carbon is a protean element—it may be dissolved in iron, or it may exist in iron in any of the varied forms in which we know it when it is free. Matthiessen, the great authority on alloys, actually writes of the "carbon-iron alloys." I do not hesitate, therefore, on the ground that the subject might appear to be without the limits of the title of this lecture, to point to one other result which has been achieved by M. Moissan. Here is a fragment of pig-iron highly carburized; melt it in the electric arc in the presence of carbon, and cool the molten metal suddenly, preferably by plunging it into molten lead. Cast-iron expands on solidification, and the little mass will become solid at its surface and will contract; but when, in turn, the still fluid mass in the interior cools, it expands against the solid crust, and consequently solidifies under great pressure. Dissolve such a mass of carburized iron in nitric acid to which chlorate of potash is added; treat the residue with caustic potash, and submit it to the prolonged attack of hydrofluoric acid, then to boiling sulphuric acid, and finally fuse it with potash, to remove any traces of carbide of silicon, and you have carbon left, but—in the form of *diamonds*.

If you will not expect to see too much, I will show you some diamonds I have prepared by strictly following the directions of M. Moissan. As he points out, these diamonds, being produced under stress, are not entirely without action on polarized light, and they have, sometimes, the singular property of flying to pieces like Rupert's drops when they are mounted as preparations for the microscope. (The images of many small specimens were projected on the screen from the microscope, and Fig. 8, E, shows a sketch of one of these. The largest diamond yet produced by M. Moissan is 0.5 millimetre in diameter.)

A, (Fig. 8) represents the rounded, pitted surface of a diamond, and B, a crystal of a diamond from the series prepared by M. Moissan, drawings of which illustrate his paper. (*Comptes Rendus*, Vol. CXVIII, 1894, p. 324). The rest of the specimens, C to F, were obtained by myself by the aid of his method as above described. C represents a dendritic growth apparently composed of hexagonal plates of graphite, while D is a specimen of much interest, as it appears to be a hollow sphere of graphitic carbon, partially crushed, in such examples are very numerous, and the surfaces are covered with minute round graphitic pits and prominences of great brilliancy. Specimen E (which as already stated, was one of a series shown to the audience) is a broken crystal, probably a tetrahedron, and is the best crystallised specimen of diamond I have as yet succeeded in preparing. Minute diamonds, similar to A, may be readily produced, and brilliant fragments, with the lamella structure shown in F, are also often met with.

The close association of the rarer metals and carbon and their intimate relations with carbon, when they are hidden with it in iron, enabled me to refer to the production of the diamond, and afford a basis for the few observations I would offer in conclusion. These relate to the singular attitude towards metallurgical research main-

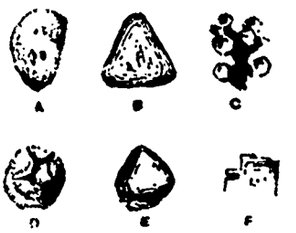

Fig. 8—Preparations for the Microscope of Diamons and other forms of Carbon obtained from Carbonized Iron.

tained by those who are in a position to promote the advancement of science in this country. Statements respecting the change of shining graphite into brilliant diamond are received with appreciative interest; but on the other hand the vast importance of effecting similar molecular changes in metals is ignored.

We may acknowledge that "no nation of modern times has done so much practical work in the world as ourselves, none has applied itself so conspicuously or with such conspicuous success to the indefatigable pursuit of all those branches of human knowledge which give to man his mastery over matter.—(*The Times*, February 22, 1895). But it is typical of our peculiar British method of advance to dismiss all metallurgical questions as "industrial," and leave their consideration to private enterprise.

We are fortunately to spend, I believe, eighteen millions this year in our navy, and yet the nation only endows experimental research in all branches of science with four thousand pounds. We rightly and gladly spend a million on the *Magnificent*, and then stand by while manufacturers compete for the privilege of providing her with the armour-plate which is to save her from disablement or destruction. We, as a nation, are fully holding our own in metallurgical progress, but we might be doing so much more. Why are so few workers studying the rarer metals and their alloys? Why is the crucible so often abandoned for the test-tube? Is not the investigation of the properties of alloys precious for its own sake, or is our faith in the fruitfulness of the results of metallurgical investigation so weak that, in its case, the substance of things hoped for remains unsought for and unseen in the depths of obscurity in which metals are left.

We must go back to the traditions of Faraday, who was the first to investigate the influence of the rarer metals upon iron, and to prepare the nickel-iron series, of which so much has since been heard. (In the development of the use of these alloys; the Societé Ferro-Nickel, and Les Usines du Creusot, deserve special mention). He did not despise research which might possibly tend to useful results, but joyously records his satisfaction at the fact that a generous gift from Wollaston of certain of the "scarce and more valuable metals" enabled him to transfer his experiments from the laboratory in Albemarle Street to the works of a manufacturer at Sheffield.

Faraday not only began the research I am pleading for tonight, but he gave us the germ of the dynamo, by the aid of which as we have seen the rarer metals may be isolated. If it is a source of national pride that research should be endowed apart from the national expenditure, let us, while remembering our responsibilities, rest in the hope that metallurgy will be well represented in the laboratory which private munificence is to place side by side with our historic Royal Institution.

MINING IN NOVA SCOTIA.

(From our own Correspondent.)

A considerable amount of dissatisfaction has been caused amongst the gold miners here by an error in the official "Blue Book."

The error appears to have been brought to light by the figures given in Mr. Mason's paper on Gold Mining in Nova Scotia published in our last issue; some of the gold miners in the Stormont district challenged Mr. Mason for his authority and he referred them to the "Blue Book," and thus the error was brought to light nine months after the "Blue Book" was published. This little incident shows very clearly how much interest the mining fraternity take in the official report of the mining industry of the province. That so glaring an error has been allowed to pass unnoticed for nine months proves beyond a doubt that the official report has degenerated to such an extent that the miners either treat it with silent contempt, or else think it is a waste of time to look through it. This state of things is far from what it ought to be: the official report should be a means of bringing the resources of the province to the notice of capitalists, and we would strongly urge the Government to seek the co-operation of the gold miners in producing the next volume. Unless some decided move is made the gold resources of this province (which are acknowledged to be promising by experts on both sides of the water) will continue to be developed in the same humdrum style as heretofore.

We are pleased to report that Mr. Pushie *et al.* are pushing (no joke meant) forward their plant for treating tailings and concentrates. Some expensive machinery is being made for them by the Truro Foundry Co., and we hope in the not very distant future to be able to report that a complete bromination plant is in operation. The plant will consist of a Collins mill and concentrator, while the concentrates will be roasted in a horseshoe furnace and then subjected to bromination in barrels. Too much stress cannot be laid on the advantage this will be to the province if brought to a successful issue, the gold miners will have a place where they can send their concentrates, and more economical methods of treating the ore will become universal. Messrs. John W. Mieir and E. S. Godfrey, of New York, are superintending the erection of machinery, and are engaged in taking samples of the various tailing dumps throughout the province with a view to purchasing.

The output of ore from the Torbrook iron mines for the month of October has exceeded all previous records, 8,400 tons of ore were produced and shipped during the month, half going to Londonderry and half to Ferrona.

The Kent *v.* Borrodaile "gold mine" suit has been finished in the Supreme Court. His Lordship reserved judgment.

The 12-inch pipes for the new Gas Co. in Halifax are being supplied by the Londonderry Iron Co.

We understand that a new company has been formed to work the Coxheath copper mine, C.B. Mr. C. M. Odell has been employed to make surveys for a new route for a railway from the mines to Campbell's Brook on the I.C.R. Dr. Peters, of Boston, and Mr. Brown, of Chicago, are preparing plans for a reduction works, which will be situated on the Grantmyre property.

Mr. John Johnston has been compelled through ill-health to resign the management of the Dominion colliery, and will take over the lighter duties of manager of the Gowrie colliery.

Mr. James Wilkes, of Montreal, has been to the Londonderry Iron Works, superintending the fitting up of furnaces for the manufacture of puddled bar iron, which the company intend producing shortly.

We regret to have to chronicle the death of Professor George Lawson, whose name has been intimately associated with the advancement of science in this province for upwards of thirty years.

We have had a call from Mr. B. M. Davidson recently who had just returned from starting the new mill on the Barasois property at Wine Harbor. Mr. Davidson reports the property looking very well. He brought up a 33 oz. brick, the result of a week's work.

The Oxford Mining Co. have started work stripping the surface preparatory to quarrying. This property is to be worked by an open cut, the ore being taken to the mill by a cable hoist.

At a general meeting of the Dominion Smelting and Refining Co., held in Halifax on Nov. 14th, a resolution was passed to wind up the company. Mr. Hardman (who has had charge of the prospecting latterly) stated in his report that the work done was not of a sufficiently encouraging nature to warrant further outlay. In all about $5,000 have been spent in arriving at this conclusion. We cannot help thinking that a more satisfactory result might have been obtained if an expert lead miner had been employed to superintend the prospecting at the start. According to previous reports by Dr. Gilpin and Capt. Evans, there is a large body of ore in sight which Dr. Gilpin estimated would run 15% of galena. Assuming this to be the case, we think that if this body had been cut through and a cheap hand-dressing plant erected to treat it, sufficient lead ore might have been obtained to pay for further prospecting.

Although the gold returns for the year ending Sept. 30th, 1895, are considerably below the average. The new official year is starting with considerable promise. We expect to hear good accounts from Modstock, Malega, Goldenville, Wine Harbor, Oxford and Central Rawdon; while there is no reason to anticipate any falling off in those mines which have mainly been instrumental in making up this year's production.

The property of the Nova Scotia Gold Mines, Limited, was sold by the sheriff on Nov. 16th to Mr. A. P. McQuarrie for $5,000. There were 26 attachments against the property amounting in all to $5,074.14.

The North Brookfield Gold Mining Co. produced a brick of 321 oz. last month.

A considerable amount of prospecting is being done in the neighborhood of Gold River and some very fine quartz has been found. We expect to hear of some very good returns from this part of the province next year. Mr. T. N. Baker, with a two-stamp mill returned 54 oz. 6 dwt. from 30 tons of quartz.

The Sherbrooke district produced 249 oz. of gold from 524 tons of quartz.

The Golden Lode mine produced 224 oz. 6 dwt. from 25 tons of quartz.

Fifteen Mile Stream continues its fine record; 385 oz. 1 dwt. of gold were obtained last month from 580 tons of quartz.

The Richardson mine produced 154 oz. of gold last month from 892 tons of quartz.

A number of gold areas in Tangiers district, the property of Dr. Jenkins, are to be sold by the sheriff.

MINING IN BRITISH COLUMBIA.

The Waverley Hydraulic Co's mine on Grouse creek made a fair cleanup this season and much satisfaction is expressed by the management that the old mine is gradually working out its salvation. For seventeen years hydraulicing has been going on season after season and this year only bed rock was reached. It is expected from now on to make an increase in each year's production.

Whittier's ditch which was contracted to Chinamen is nearly completed. It is nearly nine miles long and there will be capacity for about 3,000 inches of water.

The Forrest Rose and St. George Hydraulic Company have finished piping and have commenced to cleanup their summer's run and from all indications the season has been a very satisfactory one.

The contractors for the tunnel for the Gold Fields Company, Messrs. Bossi and Navard, are still pushing work with vigor and although handicapped by soft ground and water enough for a sluice head they are making over six feet for every 24 hours. The tunnel mentioned was designed to drain the ground to be worked by Whittier's hydraulic lift and one can get some idea of the immense amount of water the old timers had to contend with in their efforts to bottom the lower end of William's creek. The old Ballarat was the lowest mine to be worked down the creek and although expensive to work was very rich and where the owners were compelled to leave off on account of the difficulties of contending with the water, it was as rich as any of the ground above. The tunnel now being run is under contract for 2,600 feet. It is expected that when the distance named in the contract is reached that a depth of about 140 feet will have been attained, but it is expected to reach bedrock at about that distance.

Wilcox and Hancock who are drifting on the old Cy Roe and Frank Orr property, are in about 200 feet and are steadily taking out pay. Last summer during the wet weather they had a bad cave which interfered with their work for some weeks, but as the ground dried out they were able to get around their cave and resume their work on a profitable basis. The ground being worked by these men is in a locality that has been travelled over for 30 years by everybody who has gone to and from Barkerville. It is ground that is not as rich as some of the old claims, but there is a considerable extent of it and there should be no difficulty in working it. The entrance to the tunnel is near the flat on Willow river and quickly runs under the road and to bed rock.

The Short Bend hydraulic mine on Grouse creek, which is managed by Anthony McAlinden, made the most successful cleanup this season that has been achieved for years, about 150 ounces being the result. The mine is on the old works where in early days fabulous sums were taken out, but on getting away from the old bed of Grouse creek the pay was lost and for a number of years the mine did not pay expenses, in fact ran behind. Several old claims on Grouse creek paid very high. A nugget was picked up in the Short Bend last summer by a tenderfoot who was poking around the ground sluices which weighed out about $46 worth of gold. He was spied by the foremon, who quickly took the nugget away from him. Miners should be very careful how they allow strangers to ransack their ground sluices, as there is no telling what chunks of gold are lying around. In this instance two other parties, Messrs. Ramos and Cameron, in addition to the foreman, saw the nugget picked up. It was a very handsome smooth piece of gold near the shape of an egg.

Last Saturday Charles S. Voorhees, president of the Robert E. Lee Mining Co., made the second payment of $6,000 on the Lee and Maid of Erin. The recipients of the money were William Dunn and Michael Sullivan, who located these two mines last fall. They were bonded for $36,000 by the owners last April to John M. Burke and Clayton Miller, who subsequently transferred them to the Robt. E. Lee Gold Mining Company, in which both hold large interests. Messrs. Dunn and Sullivan are among the fortunate prospectors of the camp. Both the Lee and Maid of Erin are fine properties and will always hold high rank in the Trail Creek district. John M. Burke will give his personal attention to their development, and no doubt the judgment he exercised in buying them will be vindicated. The new steam hoist, pump and power drills will be here in a few days. As soon as they can be got in place the work of raising ore from the shaft of the Maid of Erin will begin, and one more shipper will be added to the list. The Lee Company is in first-class financial condition, and it would be gratifying to know that some of the other good properties of the camp were in such competent hands. Much of the credit for the sound condition of the Lee Company is due to H. L. Wilson, the treasurer. Mr. Wilson is a very careful, painstaking man, and the company is fortunate in having him for its treasurer.—*Tribune.*

Very good progress is now being made in sinking the Le Roi shaft and the work will soon be completed. The finest ore ever taken from the Le Roi is being found in this shaft nearly 400 feet below the surface. One block weighing 80 pounds was blown off last week and when tested ran $80 in gold. It is much impregnated with quartz and presents a beautiful appearance. The piece will be taken to Spokane and placed on exhibition. It is an encouraging fact that quartz increases in the ore of this camp as deep workings are opened up.—*Rossland Miner.*

The preliminary steps have been taken for the establishment of a 200-ton matteing plant in the immediate vicinity of Rossland for the reduction of Trail Creek ores. This comes as a result of the visit made here recently by Mr. Larsen of Colorado. Mr. Larsen spent a week in an investigation of the ores of this camp. He became thoroughly convinced that they are subject to concentration by the process now in use in the bi-metallic smelter at Leadville. Mr. Larsen came to the conclusion he could throw from 6 to 10 tons of ore into one of copper matte at a cost not to exceed $4 per ton. He went from Rossland to Spokane, where he laid plans before several substantial mine owners who have Trail Creek interests and he met with reasonable encouragement. It has been determined to form a company with a capital of $250,000 and to erect a plant with a capacity of 200 tons a day. The site for the works has not yet been selected, but it will probably be not far from Center Star gulch.—*Miner.*

The sale of the Cliff mine and the St. Elmo Consolidated to the Lillooet, Fraser River and Cariboo Gold Fields, Ltd., of which Frank S. Barnard, M.P., of Victoria, is the representative, is one of the largest mining transactions that has ever taken place in the Northwest, says the Rossland *Record*. The consideration of the sale of the sale of the Cliff is $150,000, and for the St. Elmo Consolidated is $75,000 in the following instalments:—$1,000 cash, $34,000 December 31st, $50,000 June 1st, 1896, and the final payment $140,000 in December of next year.

The Cliff is one of the most thoroughly developed properties in the Trail Creek district, the lower tunnel being 142 feet, 95 feet of which being in ore that will run $12 to the ton. The upper tunnel is in 150 feet in ore said to be valued at $25 a ton; a shaft 26 feet is also in ore, besides 125 feet of cross-cuts and seven open cuts in ore, making in all about 453 feet of development. The best ore is in the upper tunnel. Col. Wharton says he is looking for a chute of ore which is plainly visible from the surface which will go not less than $40 to the ton. The run is 4 feet solid, carrying 20 per cent. of copper.

The Cliff was located in September, 1893, by Guy Reeder, who received a grub stake from Charles Crossman. Col. Wharton and John R. Cook bought Reeder's interest, and Wharton Bros. the interest held by Crossman in the spring of 1894. No development had been done up to that date aside from the assessment work. Col. Wharton had faith in the mine from the start and believed he had a fortune in it, and when he was offered nearly $100,000 for it last summer his friends thought he was making a mistake. He thought not, and the sale just made justified his judgment.

The Columbia River Hydraulic Mining Co. have given F. G. Kegler a contract for some $3,000 worth of work on their property in the Big Bend, which will be done during the winter. The lumber will be cut in the vicinity, and five men employed on the job. Two hydraulics and 3,400 feet of pipe have already been ordered.

The shipments of coal from Nanaimo and Wellington last month were:

	Tons.
New Vancouver Coal Co.	16,677
Wellington	19,535
Union	17,450
Total	53,662

The shipments for September amounted to 55,676 tons or 2,014 tons more than those in October.

The bullion and ore shipments from the Slocan district at last report were:

	Tons.	Value.
Smelter, Pilot Bay	140	$14,000
Le Roi mine, Rossland	573	28,650
Josie Mine, Rossland	128	6,400
War Eagle Mine, Rossland	70	3,500
Goodenough Mine, Sandon	20	2,000
Wellington Mine, Slocan District	17	1,700
Alamo Mine, Three Forks	17	1,700
Total	965	$57,950
Total so far for 1895	25,242	$1,977,450

A. B. Hendryx, of the Pilot Bay Smelter, says that "the compressor and drills at the Blue Bell mine will be ready for operation in about twenty days. It is the intention to keep one of the drills continuously at work on the vein of copper on the lower level. Many things are hoped for from this working of the copper. It assays well, and we shall determine what there is in it. There is another vein of copper-bearing ore in the mine which carries one ounce of silver to each per cent. of copper. We are taking out large quantities of ore every day from the Blue Bell and sending it to the smelter. At the smelter the work is going on much as usual. We are using ore from the Skyline and Number One mine at Ainsworth; in fact, we are taking their entire product. The Hooker Creek district will be heard from. The owners of one claim sent down some fine ore to the smelter, and the returns were a surprise to them all. Another season will witness many new and rich discoveries in the West Kootenay."

LEGAL.

Fraser River Mining and Dredging Co., Ltd. v. Gallagher—Important Decision to Company Promoters.

Chief Justice Davie's judgment in this celebrated case, which was heard recently in the Supreme Court of British Columbia, is as follows:—

In Broderip v. Salomon, 12 R. 89, a company composed only of Salomon and his relatives had been formed under the Companies Act, 1862, for the ostensible purpose of purchasing and carrying on Salomon's business, but with the manifest object of swindling everyone who might become connected with it, outside of the Salomons. At the instance of creditors, the sale of Salomon's business to the company was declared to be fictitious, and Salomon was directed to indemnify the company against its debts and liabilities. It has been stoutly contended that the Fraser River Company was a mere scheme to swindle subsequent shareholders, and that acting upon principles similar to Salomon v. Broderip, Alworth, who had purchased a controlling interest in the shares of the company, at a comparatively insignificant price, should be ordered at the suit of subsequent shareholders to contribute to the assets of the company, the difference between the nominal value of the shares and what he paid for them. But I am of opinion that, so far from the formation of the company being a swindle on the part of Alworth, the company, so far as he was concerned, was formed with perfect honesty of purpose, that he put his money (which was the principal money furnished) into the concern in good faith, with the object of developing what he believed to be a valuable property, and that the advantages complained of in this action were purchased *bona fide* only for his own protection, and to guard against the possibility of his interests being sacrificed by those who had contributed nothing, or next to nothing. The facts of the case are these:

C. S. Bailey, W. Bailey, T. J. Beatty, W. H. Gallagher and James Tallyard had applied for a lease from the Government of 42 miles of the Fraser river, for the purpose of dredging for gold. Being without funds for entering upon the work, they made an agreement, dated 9th February, 1894, with C. E. Crockett, who claimed to have experience in such enterprises, to furnish $25,000—$12,000 within 90 days and the remainder from time to time as required, upon condition that a company was to be formed with a nominal capital of $2,500,000, divided into 250,000 shares of $10 each, of which Crockett was to receive 51 per cent. He was to be the general manager of the company, and was to expend the money in building a steam scow and completing and equipping pumps and machinery necessary to successfully operate the claims, and to be at work inside of 90 days. By a supplementary agreement of the same date, in consideration of $54 (receipt acknowledged), Bailey and the other holders of the lease assigned to Crockett an undivided one-sixth interest therein, Crockett agreeing to pay one-sixth of all future expenses in connection with the claims, agreeing to vest in the Anglo-American Mining Company the use of any patents he had for mining purposes and to act as general manager of the company, giving the company the benefit of his knowledge until the company should be in successful operation.

Crockett was without means to find the needed $25,000; so he went to Duluth, where he enlisted Alworth, who on behalf of himself and friends engaged to find the necessary funds, Crockett himself contributing $2,000. The terms upon which Alworth found this money, except as to a further transfer of shares by Crockett, to which I shall presently refer, are contained in an agreement dated 10th May, 1894, made between the Baileys, Beatty, Gallagher and Tallyard of the first part, and Crockett of the second part, and Alworth of the third part, which, after reciting the leases (or applications for them), the expenditure by Crockett of time and money in preparatory development work, and in enlisting Alworth and his associates in the enterprise, goes on to provide for the completion of the leases, and the formation of a company to be called the Anglo-American Mining Co., Ltd. Liability, to be capitalized at the same amount divided into the same number of shares, as provided by the agreement of the 9th February, 1894, and having for its purpose the construction and operation of suitable and proper plant for the development of the property, and the dredging of the bed of the river for gold. The agreement goes on to provide for the transfer of the leases to the intended company, Crockett engaging to devote himself wholly to the procuring and equipment of suitable plant for dredging the river. Alworth agrees to pay into the treasury of the company the necessary moneys, including the first year's rental upon the leases, such moneys in the aggregate not to exceed $25,000, to be paid from time to time as required, "it being by all the parties hereto assumed and believed that the moneys herein provided for shall be sufficient," for the purposes of dredging operations. For these considerations Bailey & Co. agreed to cause to be issued and delivered to Crockett 51 per cent. of fully paid and unassessable capital stock, in full discharge for his services, etc., and Crockett agrees immediately upon receipt thereof from the company, in consideration of the moneys agreed to be furnished by Alworth, to transfer and deliver to Alworth $850,000 in par value of the stock of the corporation. The remaining 49 per cent. of the capital stock is to be issued and delivered to the Baileys & Co., as fully paid and unassessable stock, "the same to be in full consideration of all the expenditures of time, money and labor by them and in full consideration for the transfer and delivery to the company of the leases.' It is then agreed that should the $25,000 to be furnished by Alworth be insufficient for the construction of the plant, and its establishment in successful operation, then that any further moneys which might be required, should be furnished and raised without Alworth contributing thereto at all; and, so as to provide an assured means for raising such further moneys when required, the Baileys & Co. and Crockett are to deposit in escrow with a chartered bank, the Baileys a one-third part of their 49 per cent. and Crockett a one-third part of so much as remains of his 51 per cent. after deducting thereout the $850,000 to be transferred to Alworth. It is further provided that this escrow stock should be held in trust to the order of a committee to consist of Crockett, Gallagher and Alworth, and that in case it became necessary to find money in excess of Alworth's $25,000, that sufficient to meet such excess should be raised by sale of escrow stock ("to be made up by contributions pro rata from respective holdings thereof") at a price to be fixed by the committee; the owners being at liberty to save their stock from sale by contributing "cash in place thereof." It is also provided that the plant is to be deemed completed and in successful operation, when the same should be accepted by the board of directors of the company.

From the evidence it appears that the company was duly formed, but before its formation Crockett agreed to turn over to Alworth one-third of his remaining interest in the company. The consideration for so doing is stated by Alworth to have been $508.42, a payment certainly made by him to Crockett, for which the cheque was produced. Crockett, on the contrary, swears that these shares were turned over to Alworth for no valid consideration, and the suggestion is that they were turned over for and as part of a scheme to give Alworth an undue advantage over the other shareholders. Still, the fact remains that $508.42 was paid by Alworth to Crockett. Crockett does not satisfactorily account for this payment; in one place he says it was paid him for his share in money realised for some stock bought from Tallyard; but that is a manifest mistake, for the Tallyard money, some $590, was a separate payment; in another place he says the $508 cheque was for a two-third share of expenses somehow or another, but how he does not explain, due from Alworth to him. In face of such conflicting statements, I am bound to believe Alworth's account, which shows that the one-third of Crockett's stock, other than the 85,000 shares stipulated for under the agreement of 10th of May, was purchased for a cash consideration of $508.00, which, as Alworth says, was for one-third of his expenses which he (Crockett) placed at that sum. I must say that I did not quite understand at the trial what this meant, but, in reading over the correspondence, I find not only an explanation of what was meant by expenses, but a cogent, because accidental corroboration of Alworth's evidence on this point; not alluded to, so far as I remember, at the trial. I refer to Crocket's letter to Alworth, dated June 8th, 1894, being a distinct offer of the share of stock in question, at the price mentioned, which is stated to be Crockett's expense so far in securing the property. It appears also that Crockett agreed to transfer a further one-third of his shares to Wood and Heimick, in consideration, as I understand Crockett, for their introduction to Alworth, and the others who put the money in. These others have no complaint to make regarding this transfer of stock to Wood and Heimick. The company was incorporated on the 3rd July, 1894, and, before its first meeting, Wood and Heimick, by indenture dated 30th July, agreed to pool their stock, amounting in the aggregate to 127,500 shares, thus giving them absolute control of the company, and at the meeting of 30th July, Alworth, Wood and Crockett were elected directors, and, conformably to the agreement of the 10th of May. 85,000 shares were allotted to Alworth, and 42,500 to Crockett, who, pursuant to his agreement with Wood and Heimick, transferred them each 14,166 shares, and the same number to Alworth. It also appears that Alworth transferred some of his 85,000 shares to Wood and Heimick for what they had cost him. Alworth, Wood and Heimick have all along acted in concert; in fact, it appears that Wood and Heimick's shares practically belong to Alworth, and they have acted throughout as Alworth's agents.

It further appears that after the $25,000 subscribed, as to $8,500 personally by Alworth, and as to the remainder (except Crockett's $2,000) by Alworth or his friends, had been exhausted, Crockett moved and Gallagher and all parties consentep to assess the escrow stock $3,000 to pay liabilities, and afterwards again a second assessment was ordered, upon the motion moved and carried by the votes of Gallagher and Crockett. Crockett during all this time was engaged in procuring and placing in position the necessary machinery and plant for the prosecution of mining operations, drawing for the necessary moneys from time to time upon the secretary, Mr. Wood, who, in turn, was kept supplied by Alworth, who, to quote from Crockett's evidence, "was very prompt in sending his money to help along the enterprise," "and there is no suggestion that his accounts are not straightforward and clear," and, in a letter to Alworth, dated August 17th, 1894, Crockett says: "I feel as though Wood getting me acquainted with you, and the fact of your getting the capital to put this thing on its feet, ought to earn me a fortune and a very large one."

Eventually, when the plant was getting towards completion, Crockett met with a mishap in running the dredge ashore. It was a pure mishap as far as I can see, and no particular blame attributable to Crockett. He seemed, however, to blame himself, and on the 2nd January, 1895, sent in his resignation, and Alworth then undertook to complete the plant. Up to this time the most perfect confidence existed between Crockett on the one hand and Alworth and his associates on the other, but, soon after the resignation trouble developed itself between Crockett and Alworth, Gallagher and the Baileys ranging themselves on Crockett's side. Some thousands of dollars more than had been raised by the two assessments were, in Alworth's opinion, required to properly complete the plant, but Crockett contended that it could be done for $100 or $150, and he and Gallagher, as members of the escrow committee, refused to levy the necessary assessment, which refusal led to the suit to compel the carrying out of the agreement, which resulted in a decree accordingly. The present suit was then brought to remove Crockett and Gallagher from the office of trustees, and was opposed mainly on similar grounds to those set up in the counter claim presently mentioned.

On the 30th day of July at the commencement of the trial I made an order removing Crockett, but Gallagher, having intimated his willingness to concur in the assessment, was permitted to remain as trustee, and the trial was adjourned. The assessment for raising the necessary money has been levied accordingly upon the escrow stock, but matters can now proceed no further, as Gallagher refuses to concur in a sale unless ordered to do so by the court, and the further hearing of the case with the object of removing Gallagher has now been proceeded with.

In this stage of the suit Edwards has been joined as a party, and given leave to counter claim against the plaintiff, Alworth, and against Wood and Heimick, and, as a co-plaintiff with Gallagher and Crockett, he complains—and I must admit with considerable reason—that he has been defrauded and deluded into buying shares at a comparatively high price which are now placed in competition with escrow stock, which is being sold for next to nothing. But who has so deluded him? Not Alworth, Heimick or Wood, so far as I can discern, but the very men with whom he is associated in this litigation, his co-plaintiffs, Crockett and Gallagher. Edwards purchased a portion of his shares at the first sale of escrow stock, which sale was ordered, as it will be remembered, by Gallagher and Crockett, and the remainder from T. J. Beatty. He says he made no enquiry regarding the formation of the company, but as alluring Mr. Edwards to the auction sale, a highly seductive and untruthful advertisement was published, and prospectus issued, prepared not by Mr. Alworth, but by Mr. Gallagher and one of the other members of the committee.

The advertisement was as follows:

NOTICE TO THE PUBLIC.

IMPORTANT AUCTION SALE OF MINING STOCK.

I have received instructions to offer for sale by public auction at my auction room 63 Cordova street, on

SATURDAY EVENING, THE 12TH INST.,

without reserve, a number of shares of the Fraser River Mining and Dredging Co., Limited.

This is no wild-cat scheme as it has been proved that there are immense quantities of gold in the bed of the Fraser river, which can only be secured by dredging on account of the strength of the current.

The plant, costing $40,000, has been purchased and set up ready for work, and it is of the best and most modern manufacture, and will soon be working, so that only a short time will intervene before large returns may confidently be expected from the present outlay; an opportunity like this may possibly never occur again to secure stock in this the most promising project for the securing of the precious metal so near the hand of man and which in the past has been so difficult to obtain.

S. J. EMANUELS,
Auctioneer.

Remember the time and place, 63 Cordova street, Saturday evening, 8 p.m.

In truth no such sum as $40,000 had been expended, and so far from the dredge being set up ready for work, both Mr. Gallagher and Mr. Beatty, as well as Mr. Crockett, knew it was stranded on a bar, and time and trouble must be expended in getting it to work. "The large returns which may confidently be expected" may or may not materialize; in the meantime it is an utterly undeveloped property. Gallagher and Beatty also prepared a prospectus—for which Alworth is not shown to have been in any way responsible, or even to have seen—the material portions of which, to put the matter very mildly, are perfect fiction. No prospecting of any kind has been shown to have been done by the Fraser River Mining and Dredging Company; in fact, it is notorious that the company, without anything but the bare word of Mr. Crockett when he went to Duluth and found Mr. Alworth and his friends, was formed to take over leases already granted to Gallagher and his associates, upon which even first year's rent had not been paid, yet the prospectus states "That the company, after spending several seasons prospecting the country and testing different dredging appliances, have secured from the Government a lease of 40 miles of the most suitable ground, * * * a thorough prospection of which shows that the bars will average $2 per yard." "The test of the different dredging appliances" was purely imaginary, as also was the statement that "The company has also secured timber limits enough to supply timber for their own use for many years;" the fact being that the company has not a foot of timber land belonging to it—a most mendacious statement all through. But, as remarked before, this production does not come from Mr. Alworth, but was concocted by the very men, Gallagher and Beatty, with whom Mr. Edwards is associated in this litigation. The company are not responsible for this prospectus, for they never issued it, and outside of Gallagher and Beatty, no one seems to have been aware of it, and Gallagher's evidence goes to show that after distributing some copies he suppressed the remainder. These gentlemen are now, through Edwards, who, after all, has but comparatively very small interest in this company, asking that Mr. Alworth, the man who has contributed all the money, shall be compelled to pay up for their benefit not only the $25,000 of which they have had the advantage, not contributing thereto themselves a single dollar, but shall pay up also the difference between the $25,000 and the 127,000 shares he holds at $10 per share. Really, if such a demand had not been soberly urged, it would be past conception.

I grant that if in debt, and being wound up, Alworth would, notwithstanding his having what are nominally paid-up shares, have to contribute for the debts of the concern to the extent of (if necessary) the face value of his shares: the Companies Act, 1890, section 20, is perfectly clear on this point. But that is not the case, no creditors intervene. In England under the Companies Act, 1862, it seems to be a debatable point whether the owner of shares sold at a discount can, during the life of the company, at the suit of the shareholder who has paid full value for his shares, be made to contribute the deficiency. Lord Herschell in the Ooregum Co. vs. Roper L. R., 1892, Appeal Cases, 125, was prepared to hold, had the point been urged, that he could not, and in *re* "the Pioneer of Mashonaland Syndicate," 3 Rep. 265, Mr. Justice Vaughan Williams distinctly holds that a fully paid-up shareholder has no right to assert such claims, either by action during the life of the company, or by petition upon winding-up. If such is the law under the English Joint Stock Companies Act of 1862 and 1867, a fortiori would it be the case under the British Columbia Companies Act, 1890. I can well understand that, proceeding under the Companies Acts of England, Lord Halsbury should in "*Re* Railway Time Tables Publishing Co., 12 R., 121," whilst holding himself at liberty to uphold the contrary rule should the case come before the House of Lords, hold that in the Court of Appeal, upon a winding-up shares issued at a discount must contribute. That undoubtedly is the law, as established by in *re* Almada and Tirito Co., 38 Ch. D. 415, 59 L. T., 159, and in *re* Weymouth and Channel Islands Steam Packet Co.,, (1891) 1 Ch. 66, 63 L. T., 686, and I should not be surprised to find that when the point comes before the House of Lords Lord Herschell's strong dictum the other way is overruled; but that is because of, and the English cases proceed upon, sections in the Companies Act, 1862, which are absent from the British Columbia Companies Act. In the English Act, under "Liability of Members," the measure of such liability is an amount sufficient to satisfy all claims of creditors; to pay all expenses of liquidation, and to adjust the claims of members *inter se*, and section 25 of the English Act of 1862 specifies as part of the information to be entered on the register of members the amount "paid, or agreed to be considered as paid," "on the shares of each member." Here we have no corresponding legislation to this, its operation; so far as liability of the shareholder to contribute seems limited to the claims of creditors. Sections 6 and 20 of the Companies Act, 1890, are as follows:

6. "No shareholder in any such company shall be individually liable for the debts or liabilities of the company; but the liability of each shareholder shall be limited to the calls and assessments to be legally levied upon the shares held by him."

20. (1) "Each shareholder, until the whole amount of his stock has been paid up, shall be individually liable to the creditors of the company, to an amount equal to that not paid up thereon, but shall not be liable to an action therefor by any creditor before an execution against the company has been returned unsatisfied in whole or in part; and the amount due on such execution shall, subject to the provisions of the next section, be the amount recoverable with costs against such shareholders."

(2) "Any shareholder may plead by way of defence, in whole or in part, any set-off which he could set up against the company, except a claim for unpaid dividends, or a salary, or allowance as a trustee."

Whatever view may hereafter be taken under the English acts of Lord Herschell's remarks, they appear to be unassailable when applied to the British Columbia Act, and they directly apply to this case: "But the question before Your Lordships does not arise in the case of a winding-up. The interest of the creditor is not in issue. The action is brought by a shareholder avowedly for the purpose of benefitting the holders of the ordinary shares at the expense of those who are possessed of the preference shares which were taken on the express condition that their holders should not be required to pay more than £5 per share. To accede simpliciter to the prayer of the plaintiff, would, as it seems to me, be to sanction a violation by the company of a solemn agreement entered into between them, and those who took the shares. I should have thought it was wrong to do this, except in so far as the contract provides for that which has been otherwise provided for by the legislature. In so far as the obligations arising under the contract do not involve a contravention of any enactment of the legislature, I see no reason why they should not have effect given to them. * * Except when the legislature has expressly, or by implication, forbidden any act to be done by a company, their rights must be governed by the ordinary principles of law, and they are free to make, as between themselves and their shareholders, such contracts as they please." (See also Canada Law Journal, February, 1894, p. 35.)

It appears to me, although the point was not urged in the argument of this case, that there is a wide distinction between the English companies' acts and our own. It was strongly urged by Mr. Bodwell that the acceptance by Alworth and by Heimick and Wood of the two-thirds of Crockett's stock, and the transfer by Alworth to Heimick and Wood of part of his 85,000 shares at bedrock prices must be taken as bribes accepted by directors, for which, upon principles laid down in "Re Nant.-Y.-Blo. case," L. R. 12, Ch. D., 738, and "Re G. Newman & Co., 12 R. 148," they must account to the company, and, as showing that Alworth was taking something which he knew to be morally wrong, reference was made to his letter to Crockett, in which he asks Crockett to write him a letter (which Crockett never wrote and does not produce), in form of a draft letter enclosed in Alworth's, denying that he, Alworth, had anything on "the side in the company," "as some persons seemed to think that he, Alworth, had some side agreement." I find myself unable to place any such unfavourable construction on Alworth's letter. I think that in asking a denial of any "side agreement" he had in mind only his position, and, honestly, asked a denial of that which could with truth be denied. It is significant that Crockett, whilst endeavoring to give a dishonest impression to Alworth's letter, does not produce the letter which Alworth asked him to write. I observe no indications of anything fraudulent or wrong in the transfers as between Crockett, Alworth, Heimick and Wood, and, in the absence of fraudulent intent, such transactions are not open to impeachment. (Lands Allottment Co. vs. Broad, 13 R., 101.)

The ground of Gallagher's defence and of Edwards' counter claim, is a charge of fraud against Alworth, which, in my opinion, utterly fails. If it could be shown, as claimed by the pleadings that the actions of Alworth, Wood and Heimick "are part and parcel of a fraudulent and collusive scheme and conspiracy between them to obtain control of the company by any means, and to practically close out all the Vancouver shareholders, and that Alworth is the prime mover therein, and Wood and Heimick are merely active tools employed by him to carry out such illegal and fraudulent schemes and purposes," there would be no difficulty in bringing justice home to Alworth. I think Edwards is entitled to some consideration, but not against the company, who had issued their shares before his purchase. He was, I think, too sanguine in buying shares without making enquiry as to the constitution of the company, but, at the same time, I think the company was blameworthy in not taking care to disclose its true position before the escrow shares were offered for sale; or, indeed, before it came into the power of Beatty, Gallagher and other shareholders to dispose of stock. On this ground, in dismissing Edwards' counter claim, which I do, I shall dismiss it without costs. (See British Seamless Co., L. R. 17 Ch. D., p. 475.)

Crockett and Gallagher are, I think, mainly responsible for all the trouble. The former was guilty of what appears to me from one of his letters of a deliberate suggestion to load the mine, and so practice a huge deception upon the public. Gallagher, besides being associated with bad company, was responsible for a fraudulent prospectus, and a false advertisement. Crockett has already been removed from the trusteeship. The order will be to remove Gallagher also, and that the plaintiffs, by original action, recover their costs of suit against Gallagher and Crockett.

METALLURGICAL NOTES.

Wet Copper Assay.—Mr. R. S. Dulin, in the Journal of the American Chemical Society, advocates the precipitation of copper by strips of aluminium *re* dissolving the copper in nitric acid, adding excess of ammonia and titrating with standard cyanide of potassium solution, care being taken that the same amount of nitric acid and ammonia are used in both the check and the assay. We have always found that when care is taken to eliminate foreign bodies and the check is made analogous in every way to the assay, that the cyanide method gives results very closely approximate to both the iodide and electric methods.

Mr. Albert Ladd Colby read a paper before the autumn meeting of the Lehigh Valley branch of the American Chemical Society on Rapid Methods of Iron and Steel Analysis. He stated that 2,444 analyses were made in a single week in the laboratory of the Bethlehem Iron Co. At the close of the meeting a souvenir was given to each member; it consisted in one of the armor-plate washers manufactured by the Bethlehem Iron Co. on which was engraved, "Accurately analyzed for carbon in 12 minutes; manganese in 10 minutes, phosphorous and silicon in 30 minutes." The name of the

member to whom it was presented and the date and place of meeting was also stamped on the washer.

After the decision of the English Court of appeals (with reference to the Mac-Arthur-Forrest patent for extracting gold from its ores by cyanide of potassium) that the patent could be upheld if the specification and second claim alone were considered, but that the first claim was contradictory and therefore made the patent invalid, the Cassels Gold Extraction Co., who own the patent, appealed to the Controller-General of Patents for leave to amend the patent, and the same was granted them. The amended patent has recently been published. The body of the specification remains unaltered. In the first claim the word dilute (as applied to the strength of the cyanide solution) has been omitted, and the second claim is really a disclaim, for it reads, "We declare that we do not claim generally the use of solutions of any strength."

A new book entitled "Economic Mining," by C. G. Warnford Lock, has just been published by E. & F. N. Spon, London. The book is divided into three parts, the first part treating of mining and metallurgical operations generally, prospecting, power drilling, blasting, shaft and well-sinking, ventilating, lighting, winning, hauling, hoisting, concentrating and reducing. The second part treats of non-metalliferous minerals and the third part of metalliferous minerals. By omitting the too customary historic sketch, the author gained space for matter of economic if not of scientific value.

Mr. M. C. Klement has succeeded in making dolomite from carbonate of lime; previous experimeaters have always worked on calcite and failed. Mr. Klement argued that as dolomite was often found in coral reefs, and Sorby has shown that the carbonate of lime in coral reefs probably existed as argonite, he therefore concluded to experiment on aragonite. From a large series of experiments he finds (1) that a solution of magnesium sulphate in the presence of chloride of sodium at a temperature of, or above 60° C. decomposes aragonite with formations of magnesium carbonate; (2) that this action increased with the rise of temperature, and with the concentration of the solution, and is greatly diminished by the absence of sodium chloride; (3) that recent coral is attacked by magnesinm sulphate in the same way as aragonite; (4) that the lagoons of modern coral reefs afford all the conditions of temperature saturation, etc., necessary for the production of carbonate of magnesia in the manner of his experiments.

The *Zeitschrift fur Amorganische Chemie*, gives a very complete account of the synthesis of metallic ores by crystalization from solution in the appropriate molten metal by Fredrich Roessler. The work includes the production of crystalline sulphides and selenides of such metals as lead, bismuth and silver, or arsenides, antimonides and bismuthides of platinum, paladium and gold. Thus, for instance, silver bismuth sulphide was obtained by adding 2 grammes of silver sulphide to 20 grammes of molten bismuth, the product was subjected to the action of nitric acid (sp. gr. (1.1) and there remained dark crystals intermixed with silver white crystals, the latter consisted of a bismuth silver alloy and finally dissolved in the acid. The dark crystals on dying, possessed a silver-blue lustre forming pretty groups of octahedra attached in rows and had the composition Ag Bi S_2, and Ag_2S; Ba_x S_3.

CANADIAN COMPANIES

Otter Flat Gold and Platinum Mining Co. Ltd., has been registered at Victoria, B.C., to operate mines in the Province of British Columbia. Authorized capital, $200,000, in shares of $5. Directors, Samuel K. Twigge, Benjamin J. Cornish, and Arthur B. Diplock. Head office, Vancouver, B.C.

Evening Star Mining Co. Ltd., registered under the Foreign Companies Act, statutes of British Columbia, 5th October, 1895, with an authorized capital of $1,000,000 and headquarters at Spokane, Wash.

Gold Hill Mining Company Ltd., registered 14th October, 1895, with an authorized capital of $500,000, and headquarters at Spokane, Wash. To operate in British Columbia.

Arganaut Gold Mining Co. of Kootenay, Ltd., is applying for incorporation in British Columbia, with an authorized capital of $5000,000, to take over and acquire in any lawful manner, mining leases or mining claims, or any other mining property, in any part of the Province of British Columbia, and in particular to acquire from Frederick Colleton Innes, two (2) certain mineral claims situate in the Trail Division of Kootenay District, known as the Eleanor mineral claim, and the Londonderry mineral claim, as recorded in the Mining Recorder's office at Rossland, and to pay for the same either in cash or fully paid up stock of the company, or the bonds, debentures, shares, stock and securities of this or any other company or corporation. Head office, Vancouver, B.C. Directors, A. Graham Ferguson, S. O. Richards and John G. Woods.

Virginia Gold Mining Co., Ltd., registered 26th October, 1885. Authorized Capital, $500,000. Head office: Spokano. To operate in British Columuia.

Richmond Developing and Mining Company, Ltd., has been incorporated to adopt and carry into effect with or without modification, an agreement dated the 29th October, 1895, between Alexander McLeod, Charles Barney, and J. T. Errington, and to carry on mining in British Columbia. Authorized capital $120,000, in shares of $10.00 each. Head office: Vancouver, B.C. Directors: Alexander McLeod, Charles Barney and John T. Errington.

Dominion Developing and Mining Company, Ltd., is seeking incorporation to carry on the business of mining in British Columbia with an authorized capital of $500,000. Head office: Vancouver, B.C. Directors: George Lawson Milne, Victoria, B.C.; John McQuinlan, John J. Banfield, Jonathan Miller, and John P. Carroll, all of the city of Vancouver, B.C.

Silverine Gold Mining Co., Ltd., registered 30th October, 1895. Authorized capital, $500,000. Head office: Spokane. To operate mines in British Columbia.

Chandos Mining Co., Ltd. Application for incorporation under Ontario statutes. Authorized capital, $199,000, in shares of $100. Head office: Toronto. Directors: J. A. Hanway, New York; Jas. Robinson, Montreal; R. H. Green, Toronto; J. G. Young, Toronto; and James Pearson, Toronto.

Krupp's Mining Machinery.

The ore concentration plant which was shown erected and in work by the firm of Fried. Krupp Grusonwerk of Magdeburg-Buckan, Germany, at the Mining Exhibition in Santiago, has been bought by the Chilian Government for the school of mines there.

El Ferrocarril reports that the ore concentrating machinery of the above named firm obtained special award and two first prizes at the Santiago exhibition.

SCHOOL OF MINING,

KINGSTON, ONTARIO.

The following Courses are Offered

1. *Three Years' Courses for a Diploma in*

   (A) Mining Engineering.
   (B) Analytical Chemistry and Assaying.

2. *Four Years' Courses for a Degree in*

   (A) Mining Engineering (M.E.)
   (B) Chemistry and Mineralogy (B. Sc.)
   (C) Mineralogy and Geology (B. Sc.)

3. *Post-Graduate Courses for the Degree of*

   Doctor of Science (D. Sc.)
   For further information see the calendar of Queen's University for 1894-95, p. 117.

4. *Prospector's Course.*

   The School offers to Mine Foremen, Assayers, Prospectors and Mining Men generally, Special Courses of Instruction beginning January 8th, 1896, and continuing eight weeks.

5. *Extramural Classes for Prospectors and Mining Men.*

   Lecturers will be sent to Mining Centres to conduct Classes in Elementary Chemistry, Mineralogy and Geology as applied to the discovery and winning of valuable minerals.

The School is provided with well equipped Laboratories for the study of Chemical Analysis, Assaying, Blowpiping, Mineralogy, Petrography and Drawing. In the Mining Laboratory recently built the operations of Crushing, Amalgamating, Concentrating, etc., can be studied on a large scale.

FOR CALENDAR OF THE SCHOOL AND FURTHER INFORMATION APPLY TO

WM. MASON, Bursar,

SCHOOL OF MINING, - KINGSTON, ONTARIO.

PROVINCE OF NOVA SCOTIA.

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

—AND—

PRECIOUS STONES.

TITLES GIVEN DIRECT FROM THE CROWN, ROYALTIES AND RENTALS MODERATE.

GOLD AND SILVER.

Under the provisions of chap. 1, Acts of 1802, of Mines and Minerals, Licenses are issued for prospecting Gold and Silver for a term of twelve months. Mines of Gold and Silver are laid off in areas of 150 by 250 feet, any number of which up to one hundred can be included in one License, provided that the length of the block does not exceed twice its width. The cost is 50 cents per area. Leases of any number of areas are granted for a term of 40 years at $2.00 per area. These leases are forfeitable if not worked, but advantage can be taken of a recent Act by which on payment of 50 cents annually for each area contained in the lease it becomes non-forfeitable if the labor be not performed.

Licenses are issued to owners of quartz crushing mills who are required to pay Royalty on all the Gold they extract at the rate of two per cent. on smelted Gold valued at $19 an ounce, and on smelted gold valued at $18 an ounce.

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

MINES OTHER THAN GOLD AND SILVER.

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

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

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

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

The royalties on the remaining minerals are: Copper, four cents on every unit; Lead, two cents upon every unit; Iron, five cents on every ton; Tin and Precious Stones; five per cent.; Coal, 10 cents on every ton sold.

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

Copies of the Mining Law and any information can be had on application to

THE HON. C. E. CHURCH,

Commissioner Public Works and Mines,

HALIFAX, NOVA SCOTIA.