The Mining Magazine

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CONTENTS

EDITORIAL

THE application of modern welding practice to the construction of hydraulic pipelines is a subject of great importance, so that the article by Mr. Reginald F. Allen, which appears elsewhere in this issue, should prove useful as well as interesting.

BY permission of Messrs. Bickford Smith and Co., members of the Cornish Institute of Engineers visited their Tuckingmill factory last month, the occasion forming part of the centenary celebrations of the invention of the safety fuse. The visit was followed by a lecture, given in Camborne, by Dr. W. Cullen on "William Bickford."

AN interesting trial took place last month at Newcastle, when a fully-equipped Diesel-electric railcar was run over a branch of the London and North-Eastern Railway. The car used is capable of carrying 60 passengers, together with their luggage, and has an express speed of 65 miles an hour, its operating costs being about half those of a steam service of the same capacity.

THE work of the 6th International Congress of Mines, Metallurgy, and Applied Geology, held in Liége in 1930, has been completed by the issue of three volumes of papers presented at this session. These cover much recent work in geology, mining, and metallurgy and should prove of great interest to members of these allied professions. Particulars of the terms of subscription may be obtained from the Secrétariat du Congrès, 16, Quai des Etats Unis, Liége.

IN future the British Engineering Standards Association is to be known as the British Standards Institution, a Supplemental Royal Charter having been granted to the association to make several necessary changes in its organization. The work of the institution is now arranged to fall into four main divisions of equal standing, responsible for the preparation of British Standard Specifications in the engineering, chemical, building, and textile industries, each being under the control of a representative council.

RETURNS from companies operating in Nigeria during 1930 show that 11,902 tons of tin concentrate were recovered, a decrease of 3,432 tons when compared with the 1929 output. Exports of tin ore over the same period amounted to 12,067 tons, worth £1,373,466. These figures are contained in the annual report of the Mines Department, which shows, in addition, a notable falling off in the number of prospecting licences granted during the year and in the labour employed. Working costs over the period mentioned fell from an average of £113 per ton to £87 per ton.

THE eleventh annual report of the Electricity Commissioners, covering the year to March 31 last, shows the results of concentrating on the development of the domestic load in order to offset the decline in the industrial demand created by present world conditions. It is also shown that a decline in consumption in the North of England has been more than countered by an increase in the South. The output of electricity rose by 3·1% to 12,332,949,844 units, the consumption of coal and coke declining over the same period by 1·4% and of oil by 555 tons. Since 1920–21 the total output of electricity in this country has risen by 138% and the output per ton of coal by 76%.

UNDER the Coinage Act of 1920 the minting of silver of a fineness of 500 was authorized, instead of the long-established standard of 925, so that the Deputy Master and Comptroller of the Royal Mint in his report for 1930 [1] is able to review the situation after a decade under the new conditions. The law of 1920 raised the coinage rate of silver to 122·1 pence per ounce and under conditions such as prevailed before the war, when the demand for Imperial silver coins was progressive, it would have been possible, in view of the recent slump in silver prices, to revert to the issue of coins of standard fineness. This result, however desirable, has not been possible, in view of the silver policy of the Indian Government, which has had such a marked influence in lowering the world demand for the metal.

[1] H.M. Stationery Office. Price 4s. 6d.

The Institution Meeting

There was a large muster of members at the November meeting of the Institution of Mining and Metallurgy and, although a good attendance at the present time seems somewhat to emphasize the bad period through which we are passing, there is no doubt the audience was to an extent attracted by the diversity of the subjects presented and also, perhaps, by the novelty of one of the papers. The business of the evening was first to discuss Mr. B. G. Luff's paper entitled "Notes on the Mica Industry in Bihar, India," which appeared in the September *Bulletin* and was summarized in the MAGAZINE for October, and then to hear Mr. F. W. Armstrong present his paper on "Models of Mines and Orebodies." Discussion on both papers was keen and interesting and the members present must have felt that their evening was by no means wasted.

It will be recalled that Mr. Luff's paper first describes the geology of the Bihar mica deposits, noting the occurrence of the mica "books," up to several square feet in area and five or six inches in thickness, in pegmatite lenses up to 1,500 ft. in length along the strike. The author shows that, owing to the irregular distribution of the mica in the rock, it is not possible to test veins ahead of mining and this feature has tended more than any other to prejudice the employment of capital in the development of the industry and to limit operations to shallow depths. Thus, as the author points out, it may be quite untrue to say that mica is not found at depth, the real truth being that no one is willing to spend money in testing the ground, as the enterprise could be regarded as little better than a gamble. The deepest mine in the Bihar district is down only 600 ft. and conditions below this depth remain to be proved. After describing the mining operations, the author gives some details of the preparation of mica for the market. The discussion was opened by the president, Mr. Pellew-Harvey, who referred to an earlier paper on the subject by Mr. G. V. Hobson, which, with Mr. Luff's paper, forms almost the whole of the literature on Indian mica mining. Mr. Pellew-Harvey described the difficult conditions obtaining in the mica market, where the mineral is grouped into so many different classes and which issues no regular reports of prices. He showed that the standard of these prices is set in India by the specialized dealers operating there and referred to recent legislation in Bihar and Orissa which aims at the circumvention of the mica thief, whose depredations have often had such a serious effect on the market. It will be remembered that during the discussion on Mr. Hobson's paper in March, 1927, both Sir Thomas Holland and Mr. Edward Barclay spoke of the ruinous and wasteful conditions under which mica was produced in India at that time and of the serious effects of systematic theft. It was stated that this was so rampant that the official figures for the mines were less than half the total exported and it is probable that the attention called to the matter at the Institution meeting had some effect in producing the legislation referred to. Finally, Mr. Pellew-Harvey dealt with the pre-eminent position of the British Empire as a mica producer. Several other speakers followed the president and it is evident that the paper forms a valuable addition to our knowledge of mica.

Turning to Mr. Armstrong's paper, the utility of mine models has often been the subject of dispute and it is undoubtedly true that much depends on the purpose for which they are constructed. As was pointed out by Mr. T. A. Rickard during the discussion, many of the earliest models built in the United States were made expressly for purposes of litigation and illustrated a particular theory or point of view, being generally of no scientific value whatsoever. Models constructed to aid in development work, however, and which help the mine executive to study the trend of ore-bodies, ore-shoots, faults, fissures, or dykes, and to devise the best methods of exploitation or exploration are of the utmost value and consequently Mr. Armstrong's paper will be of assistance to managements contemplating their preparation. In the early part of the paper the author classifies mine models into three main types—solid, skeleton, and plate—the later part of the paper describing several important models in existence, one of which members were privileged to see. This was a model of the Roan Antelope, constructed on horizontal glass plates, and the procedure adopted by the Selection Trust in its preparation was fully described by Mr. Anderson. Mr. Armstrong laid particular stress on what might be called the capacity of a mine model and was disposed, in consequence, to be somewhat unkind to the geologist and his microscope slide. It should,

however, be remembered that the most accurate of mine models may deceive the layman, on which point we are reminded of an amusing incident which occurred some years ago. Two shareholders of the Great Boulder, after the annual meeting—not after the luncheon!—were examining a model of the mine. They noted the black and gold colouring used—the former to represent the ore extracted, the latter the ore still to be mined—and observed one to the other: "Well, I never knew before that the Great Boulder was a coal mine as well as a gold mine."

A Geological Map of Central Africa

The first official meeting of African geological surveys was held at Kigoma, Tanganyika Territory, in July last, among those attending being members of the surveys of Tanganyika Territory, Nyasaland, and Uganda, the director of the geological survey of the Comité National du Kivu and a representative of the Comité Spécial du Katanga, the director of the Mining Department of French Equatorial Africa, Dr. D. M. Davidson, of the Rhodesian Selection Trust, Dr. F. Kirchstein, of Kigoma, and Mr. C. Gillman, chief engineer of the Tanganyika Railways. The meeting lasted fourteen days, of which six were devoted to excursions, the discussions on the other days covering a suitable range of topics, including Pre-Transvaal sedimentary deposits, the Katanga and Karroo systems and their economic geology, Post-Karroo deposits, intrusive rocks, the crystalline complex, tectonics, and palæo-geography. The proceedings of this inaugural session are now available and indicate that, while the meeting was mainly concerned with the correlation of rock formations, the drafting of a geological map of South Equatorial Africa was also considered. As many mining companies are interested in the elucidation of the geology of this part of Africa the progress made at this meeting seems well worthy of closer examination.

The satisfactory course of the discussion at Kigoma rendered it fairly easy to draft a geological map of the areas mentioned and, in view of the economic and scientific value of the work, it is desired to publish it at an early date. Such a map should be of great assistance to those conducting geological research in Central Africa, whether it be for a government survey or for other purposes, but it should be especially valuable to mining companies and others interested in the development of this part of the continent. The scale of the map has been fixed at 1 : 5,000,000. Since no funds are at present available it will be necessary to ask for subscriptions. It is estimated that the cost of production could be met if each of the governments and the other interests concerned subscribed £10 on the understanding that they should each receive in return five copies of the map. Such an appeal, although admittedly made at a difficult time, deserves wide support, for the cause is worthy and the object desirable, and for these reasons the project merits success.

In giving further consideration to the problems involved in the study of Central African stratigraphy it may be recalled that in April last there appeared in the MAGAZINE a short article by Mr. G. C. Barnard, which summarized, with the aid of several tables, the state of our present knowledge on this subject. The report of the discussions at Kigoma and the results obtained by Mr. Barnard serve to show how little can be expected to result from such meetings. It may be possible to discuss and agree on certain wide problems which, while of great help in the better understanding of world geology or as a step to the clarification of our ideas on African geology, cannot be of much help in the precise correlation of many Central African rock types. Most of the work here is lithological and petrological and it is very evident that correlation can make but little progress unless the various surveys go farther than the exchange of news and views and actually exchange personel. A man must carry his working knowledge of rock types with him and it should be possible so to standardize survey conditions in various parts of Africa that neither seniority nor pay should be lost whenever a geologist was seconded for work with some other unit. Until the advent of such an ideal scheme, however, the best use must be made of discussion and tentative correlation, and it is satisfactory to note the smoothness of the proceedings at Kigoma. The vast amount of experience in work of this kind which is necessary for satisfactory geological mapping in Africa lends urgency to another problem which will sooner or later become serious. The present financial stringency is having its effect on colonial governments as on others and many economies are being

initiated which savour rather of panic than thoughtful administration. Scientific work is invariably among the first branches of the Civil Service to feel the axe and the curtailment of the geological surveys in East Africa has already begun. Perhaps this is inevitable. Nevertheless, it should be realized by those concerned that a certain amount of experience and knowledge has been laboriously acquired at considerable expense and that a hurried use of the economic axe may lose it for all time.

United States Bureau of Mines

The wide field covered by the work of the United States Bureau of Mines and the fact that so much of its attention is devoted to metal mining or the mining of non-metallic minerals other than coal renders the report of its director for the year to June 30 last of more than passing interest. As usual, the report lays great stress on the campaign for safer conditions in the mineral industry and the director concludes that there is now good reason to believe that mining will soon take its place with the railways and other industries, which have shown that successful industrial work can be done with due regard to the health and safety of those engaged in it. It is pointed out that falls of roof and mineral are responsible for the death of many underground workers annually and the adoption of systematic timbering by many important companies in the United States, with the resultant reduction of mining hazards, is directly attributed to the work of Bureau engineers. As regards explosives, it is stated that continued experience has confirmed the opinion already held that the permissibility method of control of their use in coal mining has operated with marked success as a safety measure, so that it now remains to aid metal mining and other engineering operations in which explosives are used by the creation of a stability list for the promotion of safety and efficiency in these industries.

Examination of the other studies conducted by the Bureau serves to remind one that more detailed information on mining and milling methods and costs at most of the leading undertakings in the United States is now available than ever before and it is stated that this has proved not only of great value to the mineral industry as a whole, but of real assistance in technical education. Among the problems upon which work has only recently been started are gold dredging and hydraulic mining, mine accounting and office management for medium-sized properties, and the methods and costs of gold mining. A series of forty-three information circulars was published during the year embodying general economic studies of mineral commodities, including a number of the rare elements, such as hafnium, rhenium, and masrium. Studies were made of the economic relations of silver to other metals in argentiferous ores, the monetary use of silver and gold, world resources of chromite, and tin and silver consumption. One important line of research deserves especial mention and that is research into the flotation of non-sulphide ores. It is reported that the results of experimental work on the flotation of fluorspar and rhodochrosite have proved commercially useful and during the year the Bureau has extended its list of non-sulphide ores concentrated by soap flotation.

There are certain minerals of which the resources in the United States are either small or of very low grade and it is natural that great importance attaches to work on the available sources of such within the country. Manganese is one of these and it is important to note that the programme for the production of ferro-manganese from the manganiferous ores of Minnesota has been completed. From an ore carrying 8% of manganese a manganiferous pig-iron was made. This was treated in the open-hearth to yield a high-manganese slag, from which ferro-manganese has been made in the blast-furnace. Thus an 80% manganese product has been successfully manufactured by the treatment of an 8% ore. Another of these minerals of special importance is potash and in this connexion it is stated that the Bureau's five-year potash exploration programme bids fair to lead to the development of a real domestic potash industry in the United States. Government drilling has demonstrated the wide distribution of potash minerals in the salt-beds of New Mexico and Texas and the existence of beds of mineable thickness sufficiently rich in potash to be of possible commercial interest has been proved. Finally, notice should be taken of an important development in the application of natural gas, as a process, which is expected to have far-reaching results, has been devised for the reduction of zinc oxide by its use. A short description of this process is given in our Mining Digest.

REVIEW OF MINING

Introduction.—The tangled state of international trade relationships, due to an extent to the anti-dumping duties, has occasioned a good deal of uneasiness, but it is hoped these may be amicably straightened out. Meanwhile, there is little improvement in industrial conditions and metal prices generally are much about the same as a month ago.

Transvaal.—The output of gold on the Rand for November was 855,102 oz. and in outside districts 45,408 oz., making a total of 900,510 oz., as compared with 945,113 oz. in October. The number of natives employed on the gold mines at the end of the month totalled 209,270, as compared with 208,987 at the end of October.

Two incidents which tended to interfere with the output of Rand mines have occurred during the past month. On November 13 a fire was discovered in old workings of the City Deep on No. 19 level West No. 2 shaft. Difficulties were experienced in approaching caved areas and the fire ultimately spread to the No. 15 level. Although it was believed to have been extinguished at the end of the month it had seriously affected the output of the mine, as well as that of the Meyer and Charlton, which was also compelled to suspend operations. The mill at the last-named mine was restarted on December 1. The second incident was a strike of white miners on the Government Gold Mining Areas, which lasted about a week, but was stated not to have interrupted operations.

The report of Luipaard's Vlei Estate and Gold Mining for the year to June 30 last shows that 369,200 tons of ore was treated for 93,417 oz. of gold, worth £395,769. The profit was £44,829 and, after adding the amount brought in and writing off the cost of the recent note issue, there was available £48,362, of which £25,000 was transferred to reserve, leaving £23,362 to be carried forward. Fully developed ore reserves at the end of the year were estimated at 1,070,600 tons, averaging 5·4 dwt.

At an adjourned special meeting of Marievale Nigel Gold Mines and Estate, Ltd., held last month, it was decided to accept the offer of the Union Corporation to prospect the Marievale property.

The report of the Consolidated Gold Fields of South Africa for the year ended June 30 last shows a profit of £149,786, against £330,896 in the previous year, and once again this is derived almost entirely from the dividends on the shares in New Consolidated Gold Fields, Ltd. Adding to this amount the balance of £55,784 brought in and deducting the preference dividends for the year, amounting to £146,456, there was a balance of £59,114 to be carried forward.

Following on the statement at the last annual meeting of H.E. Proprietary (New) steps have been taken to simplify the accounts. It is proposed that the company should go into voluntary liquidation and that a new company with similar title and capital should be registered to acquire the whole of the assets, shareholders to receive one new fully paid share for each share at present held.

The fluctuations of the sterling exchange have tended to interfere with the transfer of Kaffir shares and to obviate this arrangements have been made for the premium on South African stamps to be fixed weekly. It has also been announced by the Transvaal Chamber of Mines that dividends declared by South African companies at the end of the year will be payable in South African currency, dividend warrants despatched from London offices being in English currency, the amount to be calculated on the rate of exchange ruling on the date dividends are payable in Johannesburg.

Southern Rhodesia.—The output of gold from Southern Rhodesia during October was 44,260 oz., as compared with 42,846 oz. for the previous month and 45,006 oz. in October, 1930. Other outputs for October were: Silver, 5,779 oz.; coal, 54,722 tons; chrome ore, 5,258 tons; asbestos, 114 tons.

During the year ended August 31 last the output of coal by the Wankie Colliery Company amounted to 765,357 tons, of which 75·31% was sold to customers, 10·55% discarded from the washing plant and sorting belts, and the remainder used in the coking plant and about the mine. The reserves of coal at the Wankie mine are estimated to be 11,298,000 tons. The profit for the year was £139,823, against £189,808, dividends paid absorbing £99,557.

Northern Rhodesia.—The report of Roan Antelope Copper Mines for the year to June 30 last shows that expenditure on development and equipment of properties was £1,708,518. The first unit of the concentrator went into regular operation on June 1, the second unit following on June 25, 39,175 tons being milled during the month and 1,818 short tons of concentrates, assaying 53% copper, railed to

Luanshya. No further diamond drilling was carried out during the period under review, the estimate of ore reserves still standing at 108,000,000 short tons averaging 3·44% copper, of which 95% is in the form of sulphide. A progress report covering the three months to September 30 accompanies the accounts and this shows that by the end of September 4½ out of the total 5 units of the concentrator had been brought into operation, 338,200 tons of ore, assaying 3·47% copper, having been milled. The total production of concentrates was 15,404 tons, of which 13,299 tons were shipped to America for smelting. Operating costs as finished electrolytic copper in New York, after making allowances for losses and costs, but not for interest and depreciation, are estimated to amount to £36·129 per long ton for 7,373 tons of electrolytic copper produced.

The report of the Rhokana Corporation to June 30 last shows that preparation for mining has commenced at the N'Kana, development being so far advanced that it is expected there will be no difficulty in supplying ore to the plant as soon as it is ready. The water encountered during development is said to be less than was anticipated, the average pumped to the surface daily being 1,250,000 gallons. Construction of the treatment plant is proceeding rapidly. At N'Changa and N'Changa West the programme of development has been considerably modified since the amalgamation of interests, but mine development is being continued on a reduced scale. It is anticipated that operations will begin at the concentrator before the end of the present year and that the smelter will be ready soon after.

The expenditure account of Bwana M'Kubwa Copper Mining for the 15 months to June 30 last was £39,944, less £5,647 credit brought in, which compares with a profit for the year to March 31, 1930, of £60,250. The interests of the company are now in the Rhokana Corporation.

Gold Coast.—At an extraordinary general meeting of shareholders of Appollonia Gold Fields held last month it was unanimously agreed: First, that the par value of the shares be reduced to 1s.; secondly, that the present unissued capital be divided into 1s. shares, and, thirdly, that the nominal capital be brought up to its present figure in 1s. shares. Arrangements have been made with creditors to subscribe at par for new 1s. shares to an amount equal to their claims.

The accounts of the Consolidated African Selection Trust to June 30 last show a credit balance of £129,164, making with £90,717 brought in a total of £219,881. A dividend of 9d. per share absorbed £37,467, increased by other disbursements to £60,187, leaving a balance of £159,694. Since the end of the year £100,000 of this has been transferred to general reserve account. The mine plant and buildings in West Africa are in good order, but only a limited amount of development work was done during the year, considerable areas of diamondiferous ground remaining undeveloped.

Nigeria.—Commendable expedition was shown in the production of the report of the Jantar Nigeria Company for the year ended September 30. The accounts show a profit of £2,638, which, added to £14,020 brought in, makes an available total of £16,658, which was carried forward. The output for the year was 253 tons, as compared with 374·5 tons the previous year, the price per ton realized being £114, against £162.

Australia.—Shareholders of Wiluna Gold Corporation have been informed by circular of some of the conclusions of Mr. C. O. Lindberg, given in advance of his report. Summarizing the geological outlook he says that, although the former estimated development rate cannot be expected, equal or better results may be anticipated at depth, and it is recognized that the mine cannot be called upon to deliver more than 25,000 tons monthly until development work is further advanced. During October, 26,564 tons of ore was treated, yielding bullion valued, together with exchange premium, at £40,385, the estimated surplus for the month being £7,657.

The report of Golden Horse Shoe (New) for the year ended September 30 last shows that 438,630 short tons of tailings was treated, yielding an equivalent of 3s. 9d. per ton, working costs being 1s. 8d. per ton. The net profit for the year was £11,770, from which must be deducted the debit balance of £2,609 brought in, leaving £9,161 to be carried forward.

India.—A severe rockburst occurred in the Mysore mine this month in Ribblesdale's section, auxiliary main winze, resulting in the death of three men. The burst is expected to affect the output for this month.

Malaya.—During the year ended June 30 last Malayan Tin Dredging in a restricted

programme treated 4,977,500 cu. yd. of ground, recovering 1,460 tons of tin concentrates, which realized £105,578. In the previous year 1,530 tons realized £169,855. The profit for the year was £36,661, the addition of sundry revenue and the balance brought in giving an available total of £148,750. Dividends paid during the year absorbed £35,000 and, after writing £328 off property account, a balance of £113,422 was carried forward.

Southern Malayan Tin Dredging during the year to June 30 treated 7,776,500 cu. yd. of ground and recovered 2,075 tons of tin ore, which realized £148,604. Production was curtailed in response to the restriction scheme. The profit for the year was £43,424, which, added to the sum of £8,220 brought in, gave an available total of £51,644. Dividends paid during the year absorbed £32,858, leaving a balance of £18,786 to be carried forward.

The report of Southern Perak Dredging for the year ended June 30 last shows that a restricted quantity of 2,720,600 cu. yd. was treated, the amount of tin ore recovered being 491 tons, which realized £35,577. The profit for the year was £1,933, increasing the balance brought in to £17,899. A dividend of 2½% paid during the year absorbed £3,325, the balance of £14,574 being carried forward. In order to strengthen the company's position and pay off the balance of a loan, the capital of the company has been increased since the close of the financial year by the issue of 17,000 £1 shares, at a premium of 5s. per share.

The accounts of the Perak River Hydro-Electric Power Company for the year to July 31 show that the restricted conditions under which tin mining is at present being conducted in Malaya have prevented any expansion of the company's business, although sales of power were maintained, the revenue from sales of electricity and hire rentals being £194,098. The gross surplus for the period was £113,514, the balance carried forward being £2,358.

Yugoslavia.—The accounts of Trepca Mines, Ltd., for the year to September 30 last show a net profit of £109,825. The dividend paid last month absorbed £55,000 and, after writing off preliminary expenses and underwriting commission, there remains a sum of £20,303, which is carried forward. The tonnage of ore treated was 256,549, averaging 12·6% lead and 7·6% zinc, extraction of the former equalling 96·64% and of the latter 84·52%. Ore reserves at the end of the year were estimated at 2,100,000 tons, averaging 10·5% lead and 7·8% zinc.

Trinidad Leaseholds.—The report of Trinidad Leaseholds for the twelve months to June 30 last shows that oil profits and other revenue amounted to £345,103, against £428,860 the previous year, a decrease largely due to charging drilling expenses against working costs instead of to capital account, as has been customary hitherto. The crude oil produced during the year was 264,156 tons, while 633,454 tons was purchased. The oil refined amounted to 971,915 tons, as compared with 962,566 tons the previous year. It is recommended that a dividend of 5% be paid, as compared with 7½% for 1929–30.

British Burmah Petroleum.—During the year to July 31 last the trading profit of the British Burmah Petroleum Company was £204,636, against £215,201 the previous year, the net profit being £124,935 and the disposable total £128,916. Of this amount dividends equal to 5d. per share absorbed £71,384, a balance of £5,970 being carried forward. The quantity of crude oil produced again shows a falling off, the output from new wells being insufficient to counteract the decline of the older producers.

Imperial Smelting Corporation.—The report of the Imperial Smelting Corporation for the year ended June 30 last shows that the amount received in dividends and interest was £129,091, general expenses reducing this to £113,581, to which must be added the sum of £35,361 brought in, giving an available balance of £148,942. Of this sum preference dividends absorbed £134,538, leaving a balance of £14,404 to be carried forward.

Mining Trust.—The report of the Mining Trust for the year ended June 30 last shows that since the last accounts 1,445,988 shares have been issued under arrangements with the American Smelting and Refining Company. The balance of income over expenditure for the year amounted to £68,038, which has been taken to appropriation account, in which expenditure at Lawn Hills and advances to subsidiary companies have been written off. Mount Isa mine is now operating smoothly and a large refinery has been erected in this country to deal with Mount Isa bullion. Operations in New Guinea are also stated to be favourably advanced.

AN ARC WELDED PIPELINE FOR HYDRAULIC MINING

By REGINALD F. ALLEN, A.I.M.M.

The author describes an all welded pipeline for the supply of water under pressure to the monitors used in the alluvial mining operations of Viborita Gold Mines in Colombia.

The object of this article is to describe what is probably the first 100% arc welded pipeline for hydraulic mining purposes. Before it was decided to adopt this method in place of ordinary riveted pipe with slip-on joints for main line and flanged pipe for branch lines, Mr. W. E. Thorne on behalf of Viborita Gold Mines, Ltd., made the fullest possible investigation into the pros and cons of arc welding a pipeline as compared with riveting and it was on his recommendation that this all-welded line was undertaken. Construction by arc welding is carried on in the United States to a considerably greater extent than in other countries and a study of pipe welding in various parts of the States having been made over a period of four years the recommendation, and the decision to adopt this process, was attended by a minimum of risk.

Arc welding of pipelines in the United States has, of recent years, become an important undertaking, 16 different lines having been constructed totalling 2,480 miles, for which work Lincoln welding machines have been exclusively used. The length of these lines varied from six miles, using two machines, up to 714 miles using 110 machines. In many cases the pipe was 8 in. in diameter and $\frac{1}{4}$ in. or more in thickness, and was delivered on the site in single lengths of 30 ft., the actual field work consisting only of joining up the pipes by bell and spigot joint, thus making the welding operation a comparatively easy undertaking.

The pipeline discussed in this article was made up from mild-steel sheets—No. 12 S.W.G.—each 4 ft. in length, the arc welding commencing in November, 1930. One operator from Habana was working alone until February 5, 1931, when a second operator from the United States commenced joining up the pipe lengths already prepared by the first operator, along the pipeline route previously cleared and levelled. On May 27, 1931, water was put through the pipe, then about 4,000 ft. long, and only one pinhole leak was found over that distance. This occurred in a circumferential weld and was quickly closed with a hammer. The line has been working for over 3 months (to date August 27, 1931) and has now a total length of over 5,000 ft. so that it can therefore safely be said to have passed a thoroughly practical working test satisfactorily without the least sign of leaks or other trouble. During this period the line has been subjected to varying climatic conditions as might be expected in a tropical country—including excessive heat by day—135° F. with a rapid fall in temperature at night to 54° F., heavy rainfalls, and periods of dry weather.

Reasons for Arc Welding Pipeline.—(*a*) *Transport Difficulties.*—To reach the mine all material is first unloaded from ocean steamer at Puerto Colombia, then sent by rail 17 miles to Barranquilla, the principal port on the Magdalena River, where it is transferred from train to Customs. This lengthy business completed, another transfer is made to river boats, which are sent approximately 460 miles to Pto. Berrio, where material is again transferred to the railway, which delivers to Estacion Sofia about half way to Medellin. From Sofia there is about 12 miles up a mountainous road by motor lorries to Yolombo, and on arrival there everything has to be conveyed 35 miles to the mine by pack mules over a mountainous trail.

(*b*) *Utilization of all Available Water.*—Owing to the great variation in water supply it is of the utmost importance to deliver to monitors 100% of the supply entering the pipeline. From what has been seen of ordinary riveted pipelines working in Nigeria and Colombia, a 10% loss would be a very conservative estimate. In addition, a riveted and slip-on jointed line must always have a maintenance gang continually caulking the joints which, in course of time, become a source of increasing loss of water. To prevent this and facilitate transport an all-welded line was decided on.

Transport.—All material was delivered in Yolombo as nearly as possible suitable for single mule transport, the average weight per package not exceeding 125 lb. Any package too large or too heavy was reduced or else sent slung between two

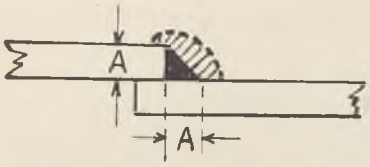


FIG. 1.—FILLET WELD FOR LAP JOINT—SHADED AREA SHOWING BEAD.

mules. Pipe sheets [1] arrived flat and being too wide to be bent and placed over the mule, and too expensive to be carried between two mules, (three plates for 28s.) were put through the pipe rolls (specially made in England) thus becoming suitable for mule transport (Fig. 3). One mule carried :—2 sheets each 26 in. by 4 ft., or 2 sheets each 22 in. by 4 ft., or 2 sheets each 18 in. by 4 ft. and 2 each 12 in. by 4 ft., or 4 sheets each 14 in. by 4 ft., or 6 sheets each 12 in. by 4 ft. Flanges 12 in. and 14 in. generally four pairs of each.

The prices paid for this work were as follows :—

26 in. pipe sheets	.	5s. each.
22 in. ,,	.	4s. 6d. ,,
18 in. ,,	.	4s. ,,
14 in. ,,	.	3s. ,,
12 in. ,,	.	2s. 6d. ,,
Flanges 12 in. and 14 in.		1s. each.

The time taken for the 35 miles journey from Yolombo to the mine varied from 2 to 2½ days according to the state of the trail, but was about 6 days for the round trip, allowing one clear day for resting. Three mule men generally accompanied 12 to 15 mules in order to expedite loading and unloading and also to give the attention required when going up and down the mountain trail. In view of the time taken for the return journey and occasional injury caused to mules, with, at times, the total loss of some, the price paid per load was quite reasonable. All material was delivered by contract price.

Shipment of pipe sheets flat and then rolled before commencing mule transport is not to be recommended. It would have been best and less expensive to have had the sheets rolled at works in England and nested up to a weight suitable for ocean, river, and train transport, and then re-arranged at the other end for mule transport. This would then have saved the cost of the pipe rolls and the labour on the handling and rolling. Incidentally when pipe sheets were passed through the rolls at the point of unloading, much of the special bituminous coating (bowranite), in which sheets had been dipped before leaving England, came off, owing to the heat and rolling action.

[1] The pipe sheets, pipe rolls, monitors, and sluice valves were supplied by Mechans, Ltd., of Glasgow.

WATER SUPPLY.—The water is conveyed through a ditch and tunnel line on a 0·1% grade and consists of :—

Ditching totalling	.	2,611·0 ft.
Tunnels	.	2,959·0 ft.
Rise for pipeline intake	.	144·0 ft.
Total	.	5,714·0 ft.

Construction started February 12, 1930, and was completed September 29, 1930, when water was put through for testing purposes. All work was by hand labour and in the case of driving the tunnels was set on contract at 32s. per metre, the contractor paying for all explosives, light, and tramming. The longest tunnels were 230, 375, 520 and 568 ft. each. Altogether 171 working days of 11 hours each were occupied on ditch and tunnel work, an average of 3·34 ft. per day. In places considerable bench cutting was required before the ditch could be commenced and had this not been necessary the work would have been completed at least six weeks earlier. At present there is a head of 350 ft. above surface level of the main deposit or about 500 ft. above lowest point of bedrock.

PIPELINE.—The intake is 40 in. in diameter, securely anchored into a reinforced concrete collar. From this point the pipeline passes down through an inclined rise (forming a firm anchor), where it strikes the surface and falls away in a direct line, with the exception of two gradual bends, to the mine workings. Total length of pipe—5,228 ft. of No. 12 S.W.G. consisting of :—

Taper intake 40 in. to 26 in.	.	20 ft.
26 in. pipe		1,032 ,,
Taper 26 in. to 22 in.	.	12 ,,
22 in. pipe		1,032 ,,
Taper 22 in. to 18 in.	.	12 ,,
18 in. pipe		1,032 ,,
Taper 18 in. to 14 in.	.	12 ,,
14 in. pipe		1,020 ,,
Taper 14 in. to 12 in.	.	12 ,,
12 in. pipe		1,020 ,,
6 tapers 12 in. to 9 in. for monitors	.	24 ,,
Total	.	5,228 ,,

There are six ball-bearing mild steel monitors having 9 in. inlet, each supplied with three extra-long high-carbon nozzles 4½, 3½ and 2½ in. in diameter.

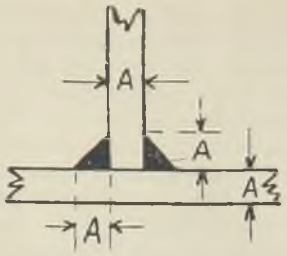


FIG. 2.—FILLET WELDS FOR T JOINT.

Sluice Valves.—These are of sectionalized type suitable for 300 lb. working pressure and constructed of mild steel throughout with gun-metal facing.

Expansions.—These are of the bellows type of pressed steel and welded around the circumference. They are of 10 S.W.G. and arranged as follows :—

3 for 26 in. line each 38 in. diameter o/a
3 ,, 22 in. ,, ,, 34 in. ,,
3 ,, 18 in. ,, ,, 30 in. ,,
3 ,, 14 in. ,, ,, 26 in. ,,
3 ,, 12 in. ,, ,, 24 in. ,,

One such is seen in Fig. 4.

Air Relief Valves.—These are 3 in. bore of mild steel fitted with bridge piece, pin and seating. To connect the valve, the saddle is placed on the pipe, the inside is marked, the valve removed, a hole burned with the arc and the valve then replaced and welded on to the pipeline. There are 30 valves placed along line and, after leaving intake and coming down the incline, one is set for each 20 ft. of head.

Packing for Flanges.—Corrugated brass rings are used for the 14 in., 12 in. and 9 in., these being found the most suitable, easy to fit, and economical.

ARC WELDING.—The following comprises total footage welded by double seam throughout.

	Longitudinal. ft.	*Circumferential. ft.*	*Totals. ft.*
Pipesheets and tapers	5,228 ft.	6,371·63	11,599·63
Expansion bellows		144·50	
Flanges and intake		879·15	
Air valves		47·13	
	5,228	7,442·41	12,670·41

For the carrying out of the above work two General Electric Company's petrol driven, 200 ampere, self-exciting arc-welding generators [1] were used. The engine is governor controlled and set at 1,700 r.p.m., as maximum, for the varying of welding current, a resistance being supplied, but it was found that the current variation obtainable by the brush moving device was sufficient for welders' needs. Machines were of standard type, except that the base was supplied of channel irons bolted, instead of welded, together, in order to facilitate transport. All parts were quite suitable for mule conveyance.

[1] These were used because the company's delivery time was 75% ahead of that promised by any British firm, and because they have a service station near the mines.

FIG. 3.—MULE TRANSPORT OF 26 IN. PIPES.

The welders' work was divided into two sections—one the making up of each single length by a double longitudinal lap-weld, and then the joining together of these sections or lengths into pipes varying from 16 up to 24 ft. long, the average length of pipe being 20 ft. These were then transferred to the second welding operator, who made lengths from 60 to 120 ft. according to ground traversed, and finally joined them on to the one continuous pipeline.

FIG. 4.—LINE LEAVING INTAKE.

To facilitate the work of No. 1 welding operator, who had first to make up the single 4 ft. lengths, these were placed on sections of rails and one pipe pushed into the other about half an inch and then tack welded by four or six small beads around circumference then whole length—say 20 feet—was placed on " X " trestles (Fig. 6) which carried small wheels acting as rollers and the pipe was revolved as the welder made a continuous circumferential weld. By this means the only stop on the part of the operator was for changing the electrode and shifting to next joint.

Electrode.—This was of standard mild steel 50,000 lb. breaking strain and supplied by the General Electric Company and by the Lincoln Electric Company. From the former their type " F " of $\frac{1}{8}$ and $\frac{5}{32}$ was used, and the latter supplied $\frac{1}{8}$ in. " Stable-Arc," both makes proving most satisfactory. The $\frac{5}{32}$ electrode was used principally for welding the $\frac{1}{2}$ in. M.S. flanges and the extra $\frac{1}{32}$ in thickness certainly permitted faster welding to be done.

Some of the electrode was received in rolls of 100 lb. net, which was then cut into lengths of 14 in. on the site. Owing to rough use during transport these rolls sometimes arrived with wrapping badly damaged or else entirely removed and if this happened during the rainy seasons the electrode was rendered useless owing to rust. Complete protection against oxidation must at all times be insisted on. Other electrodes purchased from the Lincoln Electric Company's Havana Agency came cut into 14 in. lengths securely packed in air-tight tins. There is a slightly cheaper import duty on rolls compared with that on electrodes already cut and packed in tins, but this small saving on rolls is more than offset by the cost of cutting and shaping straight after arrival at the mine. One small boy at 2s. per day was, however, able to cut sufficient electrode to keep the two operators well supplied.

Distance Operated from Machines.—Machines were supplied with 60 ft. of special flexible copper cable which was sufficient for the machine used only in the shop, but as No. 2 machine had to be moved as the pipeline advanced (Figs. 7, 8, and 9), and to avoid continually taking down, advantage was taken of some No. 8 weather-proof single copper wire already on the mine which was used in parallel and in one length of 400 ft. The machine by being placed in a suitable position enabled 800 ft. of pipeline to be put together without moving. When required the machine was taken down into three parts—generator, petrol engine, and base—transferred by six men, and then re-assembled, the average time for this being three hours.

Cleaning Pipe Sheets and Pipes.—Before attempting arc welding of any description it is absolutely necessary, in order to obtain a satisfactory weld, that the metal at and around the part to be welded should be perfectly clean and free from rust, paint,

oil, or any foreign substance, otherwise the metal being deposited will not penetrate or fuse properly, but remain on the surface. The pipe sheets in question were coated with "bowranite," which could only be satisfactorily removed from around the joint by first using small iron scrapers and finishing off with filing until the metal showed bright and clean. For ordinary field work when pipes are not under cover or protected against rain and damp it is not advisable to have them cleaned too far ahead of welders requirements otherwise rust will form, necessitating extra time and cost for re-cleaning. Should some unforeseen stoppage arise causing delay in welding of material already cleaned the use of a coating of oil or grease as a temporary rust preventative is not permissible as complete removal is difficult under ordinary field conditions, and once applied it penetrates into the surface of the metal and on heat being applied the oil or grease comes to the surface and will carbonize, making it brittle at the part welded. Frequent application of a steel wire brush to remove scale or small particles of fused metal is important. Each time operator stops or changes electrode the metal at and surrounding part last finished should be well brushed.

Welding Currents.—Owing to the varying conditions under which arc welding is undertaken it is almost impossible to give definite figures. The General Electric Company publish information which is approximate and can only be used as a guide.[1]

Electrode Diameter In Inches.	*Amperes Hand Welding.*	*Corresponding Plate Thickness In Inches.*
$\frac{1}{16}$	50–100	up to $\frac{3}{16}$
$\frac{3}{32}$	100–150	up to $\frac{1}{4}$
$\frac{1}{8}$	125–175	above $\frac{1}{8}$
$\frac{5}{32}$	150–200	,, $\frac{1}{4}$
$\frac{3}{16}$	175–350	,, $\frac{3}{8}$
$\frac{1}{4}$	225–400	,, $\frac{3}{8}$

It is possible to use the same size electrode with different thicknesses of plate or material to be welded, but the thicker the plate, the heavier the current. In this particular welding of pipe sheets, the current was 80 amps. for the first weld and 100 for the second using $\frac{1}{8}$ electrode.

Fig. 5.—Rolled Pipesheets awaiting Welding.

Welding Speed.—To state definitely what this should be is difficult, as so much depends on local conditions, which may vary considerably, and also on the skill of the operator and his disposition to accomplish as much as possible in his working hours. In order to prevent any possible trouble with the operators it is always advisable to have a very definite form of agreement stating exactly what they have to do and the hours to be worked. Unless this is done and they are engaged to work in a foreign country much trouble may arise.

Although makers of different machines publish tables of indicated speeds for various size electrode and thickness of material to be welded these cannot apply to all conditions

[1] General Electric Arc-Welding Manual.

FIG. 6.—No. 1 WELDER, HAVING TACK-WELDED SINGLE 4 FT. PIPES TOGETHER, COMMENCES CIRCUMFERENTIAL WELDING.

of field work, which are generally less favourable to the operator when compared with those existing in a factory. The most common type of weld used when operating by hand are fillet welds as Figures Nos. 1 and 2 on a "lap" and "T" joint respectively. The following figures are given by the General Electric Company.

Thickness of Material. In Inches.	*Welding Speed. Single Fillet. Feet per Hour.*[1]
$\frac{3}{32}$	20
$\frac{1}{8}$	16
$\frac{5}{16}$	13½
$\frac{1}{4}$	11½
$\frac{5}{16}$	9
$\frac{3}{8}$	6⅔
$\frac{1}{2}$	4
$\frac{5}{8}$	2⅔
$\frac{3}{4}$	2

The results of the work described here show that an average of 12 ft. per hour, actual working time, using $\frac{1}{8}$ electrode is practicable, and what is more important, gives a leak-proof welding speed. Comparing this with hand riveting in the field, it is probably much less expensive and faster. The labour cost is certainly much less for arc welding than riveting, as one operator and a labourer do the work of an entire riveting gang, while the power necessary to operate a welding machine is about the same as that required to work one compressed-air riveting outfit.

Approximate Rate of Disposition.—The following figures are quoted by the General Electric Company :—

Electrode Diameter.	*Current in Amps.*	*Hand Welding. Lb. per hr.*
$\frac{1}{16}$	50–100	1½
$\frac{3}{32}$	75–150	2
$\frac{1}{8}$	125–175	3
$\frac{5}{32}$	150–200	3½
$\frac{3}{16}$	175–300	4
$\frac{1}{4}$	225–400	5

Our actual field welding averaged at 0·267 lb. per ft. of double welding seam, using $\frac{1}{8}$ electrode, equal to 3·204 lb. per working hour. The first weld was $\frac{5}{16}$ in. in width. The second or overlaying weld was $\frac{1}{2}$ in., which compares favourably with the figure given by General Electric Company. In a test made in England, under workshop

FIG. 7.—No. 2 WELDER JOINING PIPES.

[1] To obtain speed in inches per minute, divide these values by 5.

FIG. 8.—WELDING MACHINE ALONGSIDE PIPELINE.

conditions, 14 ft. of double welding took 1 hr. 20 mins. using $\frac{1}{8}$ electrode. This extra time was probably due to that particular operator being inexperienced in welding plate so thin as No. 12 S.W.G., and while a lower speed than this was made by our No. 1 operator on commencing he gradually improved after a few weeks on his work. According to the Lincoln Electric Company of New York, the approximate number of feet that should be made per hour for a single fillet weld using $\frac{5}{32}$ electrode is 31, or $15\frac{1}{2}$ feet for double seaming. If smaller than $\frac{5}{32}$ is used the speed is increased about in proportion as size of electrode is decreased.

Electrode Metal Consumed.—This is divided into three items :—

(*a*).—Electrode actually deposited in the welding operation.

(*b*).—Electrode lost during welding, which in form of small particles or metallic globules falls away and is not used or deposited.

(*c*).—Short ends of electrode which are discarded from electrode holder. (When using an automatic welding machine this continuous loss does not occur).

The following figures are interesting :—

	(General Electric figures)		*As Determined at Mine.*
	Hand Welding. %	*Automatic Weld.* %	%
Metal usefully Deposited .	75	90	78·58
Metal lost	10	10	7·14
Metal discarded	15	*Nil.*	14·28

In this respect there was a close practical agreement with the General Electric figures, although the additional 3·58% of electrode usefully deposited would amount to an appreciable saving had this pipeline been longer. In any case a saving of electrode consumption depends on the ability of the operator to do continuous work with the one electrode, and, of course, on the quality of it. Electrodes having a high carbon content are erratic in use and give poor penetration. Any weak spots known to have developed during welding should be cut out before proceeding with that particular part.

FIG. 9.—PIPELINE LEAVING INTAKE AND EMERGING FROM INCLINED RISE.

FIG. 10.—PART OF THE WORKING PADDOCK—12 IN. LINES.

Welding Operators.—The rate of pay of welding operators varies according to the country from which they are obtained and that to which they are sent. Our No. 1 operator, from Havana, received from £40 to £45 per month inclusive of overtime, while operator No. 2, from the United States, received £70 inclusive. In the case of the latter, his working month consisted of 28 days and full pay while travelling. In view of the salaries paid it is naturally important that these operatives should be occupied as near 100% time on actual welding, the cleaning and preparing of pipesheets and pipes and finally placing them in position being done by the respective welding gang labourers as might be preferably indicated by the operators themselves. Unity in this particular work is of great importance as a time saving factor.

A plentiful supply of welders' gauntlet gloves are a necessity and also clear pieces of glass to cover the dark one inserted in the helmet. With care one piece of the glass specially made to prevent the injurious light rays from reaching the eyes of the operator will last several months. The clear glass acts as a protection against small particles of molten metal pitting or otherwise damaging the dark one. Under no circumstances should one view welding operations without proper protection for the eyes as even a brief exposure with the naked eye to direct rays of the arc will have painful results, and if persisted in permanent injury such as cataract will result.

FIG. 11.—WATER MEASUREMENT, VIBORA RIVER.

Comparative Costs.—It is seldom that any two pipeline construction jobs are alike and as this one is believed to be the first all arc-welded line the costs are of interest, but can only be taken as a guide for construction in a country having equally high customs duties and long distances to transport under difficult conditions. Climate is another big factor of cost due to increased wages also ability to work without undue delays owing to bad weather.

Time lost by No. 2 Welder owing to climatic conditions: March, 24 hours; April, 36 hours; May, 84 hours.

The reason for basing the cost on per foot of single weld is that this might probably be sufficient for welding a pipeline not exceeding 200 ft. head, but as this particular pipeline will have a head of 500 ft. additional security was necessary and so double welding seams were made throughout. An arc weld with a bead ensures 100% strength and reduces leaks to a minimum. The extra work and cost has been amply justified. Mention should be made that had similar work to be done in a country with easier and cheaper transport facilities, lower Customs charges, and more intelligent labourers, then an appreciable reduction in cost of the work should be possible. Ordinary unskilled labourers' pay is 4·8s. per day rising to 6·8s. for a semi-skilled worker.

Depreciation of Welding Machines.—In the above costs no allowance has been made for the two General Electric machines. The cost of these amounted to $2,774·33, plus $500·00 for Customs and freight charges, or a total of £654 17s. delivered on mine. The machine used by No. 2 operator was very little used compared with No. 1 machine and will probably be sold for £229 4s. or 70% of cost at mine. No. 1 machine will be kept for future use, such as building up worn out liners for elevators and general repair work. Both machines are in excellent condition and first class working order. For purpose of allocating a proportionate cost of machines to welding of pipeline it has been decided to charge 40% of No. 1 machine and 30% of No. 2 to this particular work making a total of £458 8s. The additional cost per foot will then be :—

	Cost. Colombian $	*Costs per ft. on 25,341 ft. welding. Colombian* $	*pence.*	
Gasoline, 2,265 gals.	1,487·94	0·0586	2·8120	
Electrode ⅛ and 5/32 3,391 lb.	602·84	·0237	1·1376	
Sundries	120·19	·0047	·2256	
Lubricating oil 50 gals.	99·78	·0039	·1872	
Files. 100	50·85	·0020	·0960	
Welders' helmets, gloves, and brushes	41·98	·0016	·0768	
Electrode holders and helmet glasses	33·18	·0013	·0624	
Carbide 156 lb.	27·83	·0010	·0480	
Kerosene	7·61	·0003	·0144	
Grease (Machines)	2·20	·0001	·0048	
				4·6648
Salaries.				
2 welding operators	3,223·94	·1272	6·1050	
Travelling expenses to and from U.S.A. and Havana	1,497·83	·0591	2·8368	
Supervision	981·00	·0387	1·8576	
				10·7994
Native wages	2,436·34	·0961	4·6128	4·6128
	$10,613·51 (£2,122·70)			20·0770d.

Cost per ft. of single weld (25,341 ft.) . . . . . 1·67s.
Cost per ft. of double weld . . . . . 3·34s.
Cost per ft. of completed pipe laid ready for working (5,228 ft.) 8·12s.

	Total per ft.
Cost per ft. of single weld (25,341 ft.) 1·67s. plus 0·361	2·031s.
Cost per ft. of double weld 3·34s. plus 0·722	4·062s.
Cost per ft. of completed pipe laid ready for working (5,228 ft.) 8·12s. plus 1·754	9·874s.

In conclusion the author wishes to acknowledge his appreciation of the willingness and loyalty of his assistants, Messrs. Langford and Heron and Sr. Ocampo.

THE BEATRICE MINE, SELIBIN, F.M.S.

By E. S. WILLBOURN, M.A., F.G.S.

In this article the author, who is Acting Director of the Geological Survey, F.M.S., gives a further account of the tin-bearing pipe in limestone which is worked at this mine.

INTRODUCTION.—The substance of this paper was communicated as a lecture, on March 1, 1931, to the Engineering Association of Malaya. In view of the fact that the original account of the Beatrice mine appeared in the MAGAZINE (December, 1926, and January, 1927), the Committee gave permission for the later record also to be submitted for publication.

The first account gave a full description of the mineralogy of the ore and of the rocks in which it occurred, with chemical analyses by Mr. J. C. Shenton and, so far as possible, repetition will be avoided in the present article. A short bibliography concerning primary tin-deposits in limestone can also be referred to in the first paper, and to that list should now be added "The Geology of Malayan Ore-Deposits," by J. B. Scrivenor. Owing to its microscopic intergrowth with mica, the quantitative chemical composition of the new magnesium borate mineral is still not definitely known.[1]

Mining developments have thrown clearer light on the origin of the pipe. When the first account was written it dipped southwards at a gentle angle, but before the paper had appeared in print, there had been an abrupt change and the ore-body had changed to be nearly vertical, indicating that its source was below the southern part of the mine, and not in the granite to the north, as had been thought before.

HISTORICAL SUMMARY.—A deposit of lode tin-ore in crystalline limestone was found at Selibin, a well-known mining locality near Ipoh, in 1923, and was followed along a total length of about 800 ft. until 1929, when, at 400 ft. below the limestone-surface, it came to an end at the faulted margin of a large mass of granite. During this period, in addition to the large quantity of low-grade detrital ore that was sold during the period that elapsed before a systematic method of dressing the ore had been arranged at the mine, 146,810·19 pikuls, or 8,716·86 tons, of tin-ore were disposed of for a total of $10,761,599·69 (Straits Currency), which is more than one and a quarter million pounds sterling, and a further output of 500 to 600 pikuls a month was maintained for more than one year after the pipe had been lost, partly by milling stone thrown on to the waste-dump, and partly by gravel-pump mining the alluvium. In addition, thousands of tons of white arsenic were put on the market.

The significance of these figures is more clearly seen when it is learnt that the capital of the syndicate of Chinese miners (The Thong Yin Kongsi) that was formed to control the mine was only £468, and that the profit during less than 6 years must have been about three-quarters of a million pounds sterling.

GENERAL DESCRIPTION OF THE DEPOSIT.—Dr. W. A. Rogers of Ipoh held Mining Lot No. 26,201, which he subleased to Towkay Leong Tean, the terms being that Dr. Rogers should receive 8% of the gross takings. In August, 1921, the sands and the sandy clay overlying the limestone were worked by gravel-pump, and a rather poor output of tin ore commenced. During the two years of working, until July, 1923, a total of 57·7 tons of tin ore, together with a small quantity of low-grade ore, was won, valued at £6,050.

At this period a Chinese woman, Lian Nyuk Chin, was working the mine, holding a 6 months' *hapthong* from Towkay Leong Tean. Late in July, 1923, an extraordinary deposit of black sand, rich in arsenopyrite and cassiterite, was found in a "cup" in the limestone between N and R (see Figs. 1 and 2). As there were no kilns for roasting the ore on the mine, and as the arsenopyrite could not be removed by washing, the ore was sold in its low-grade condition at a price of less than £30 a ton. Even at this low figure, the fortunate Lian Nyuk Chin was able, during the few weeks that still remained of her tenancy, to dig out enough ore to realize more than £16,000 sterling. Towkay Leong Tean then assumed the working of the mine, on behalf of the Thong Yin Syndicate, kilns were erected, the arsenical ore was roasted, and high grade tin ore was produced after August, 1923.

[1] We are informed by Mr. Scrivenor that purer material than that analysed by Mr. Shenton was brought to England by him this year and that a report by the staff of the Imperial Institute will be submitted for publication later.

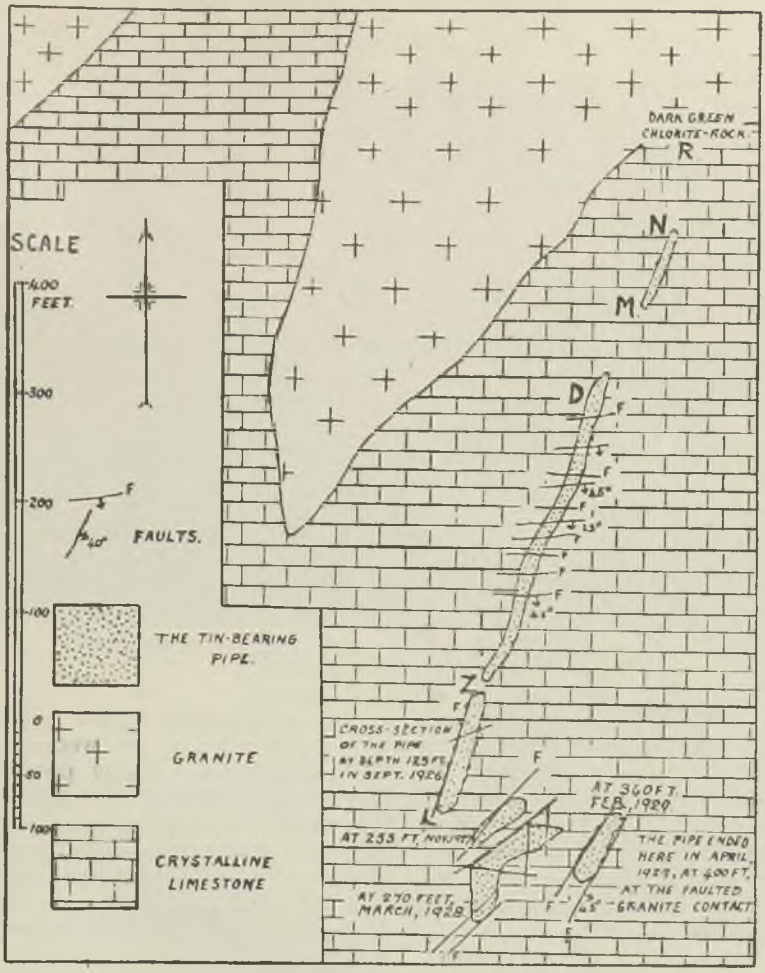


FIG. 1.—GEOLOGICAL SKETCH MAP OF THE COUNTRY AROUND THE BEATRICE MINE, ALL ROCKS BEING COVERED BY ALLUVIUM.

The deposit of black sand rich in arsenic and tin was the sheddings from a pipe or chimney of lode-ore in the crystalline limestone. At one stage in the history of the Kinta Valley, before the deposition of the tin-bearing alluvium which now lies on the ancient bedrock of limestone, schist, quartzite, and granite, this tin-bearing pipe protruded from the limestone, and erosion had deposited the heavy black sand in a deep hollow in the irregular limestone-floor, shielded from currents which might have swept it away. It became covered by alluvium, which also buried the pipe itself under 20 or 30 feet of sand and clay, so protecting it from further erosion. The black sand was made up of quartz, arsenopyrite, tourmaline, and cassiterite, with small quantities of chalcopyrite, pyrite, zircon, and topaz. The arsenopyrite, cassiterite, and chalcopyrite were sheddings from the pipe; the quartz, tourmaline, zircon, and topaz had fallen into the cup from the sandy material swept by currents over the spot; the pyrite had probably been deposited from solution, after the alluvium had covered up everything.

In September, 1923, removal of the alluvium by the gravel-pump had revealed what was apparently the cap of a tin-bearing lode in the limestone, striking 15° by 195° (NM in Figs. 1 and 2, and see also Fig. 3), 75 ft. long, by about 20 ft. wide, though these figures were only approximate, as its southern end and both of its sides were still covered with sandy alluvium. Part of the ore-body

was oxidized to a rusty looking mass of iron oxide, coated with green crystals of hydrated iron arsenate (scorodite), part was still unoxidized, with a large amount of arsenopyrite. There was a lot of cassiterite in both types of stone. An examination of the northern end (N in the figures) showed a clear-cut surface of contact dividing the ore from the limestone, but the contact was, nevertheless, quite irregular in shape. Thus the ore-body was different from the usual was discovered in this last locality, though there were various dykes and fissures with interesting minerals which have been previously described at length in the MAGAZINE. The geology of the district is illustrated in Fig. 1, where the pipe is seen occurring in crystalline limestone near the margin of a large mass of granite, from which the granite-barrier in the north was an offshoot. The letters used in the following description are those marked in Figs. 1 and 2.

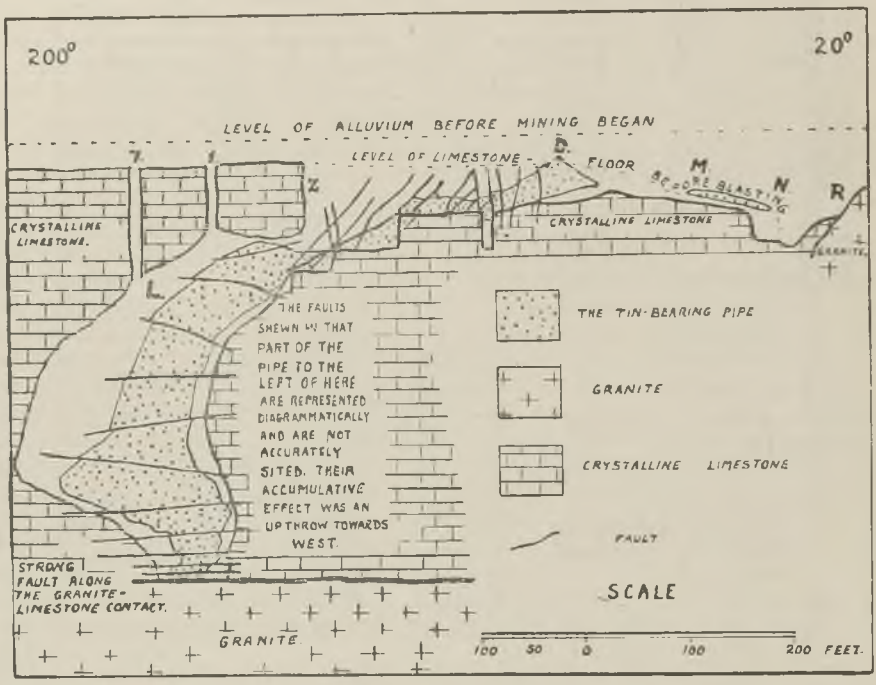


FIG. 2.—VERTICAL SECTION THROUGH THE PIPE AT THE BEATRICE MINE. THE SURFACE OF CONTACT BETWEEN THE GRANITE AND THE LIMESTONE, AT A DEPTH OF 400 FT., IS A PLANE DIPPING E.S.E. AT 45°.

type of lode filling a fault-fissure with well-marked walls, and later mining-work showed it to be a pipe with its length nearly horizontal. The tin-bearing stone was soon blasted away, leaving barren crystalline limestone underneath.

For some weeks the pipe was lost, but the deposit of black sand in the hollows between N and R was so extensive that the whole of it was not extracted until February, 1926. A mass of weathered granitic rock was uncovered on the north side of the cup, at R, disclosing itself as a barrier about 200 ft. thick, separating the area of limestone in the south, where the pipe was, from another limestone-area in the north. No lode-tin

At the contact of the barren limestone with the granite at R, was a narrow band of a dark-green mineral, chlorite, two or three inches wide, with a zone next to it, one foot thick, of granite with sufficient chlorite to colour it dark-green also. The chlorite was the result of chemical reaction between the granite and limestone at the time of the granite's intrusion, and it was there before the formation of the tin-bearing pipe. This spot and all the area to the north are now covered with tailings, but, while accessible for examination, the very important fact was learnt that no shearing had occurred at the contact, a striking difference from the contact at the other end of the pipe, to be

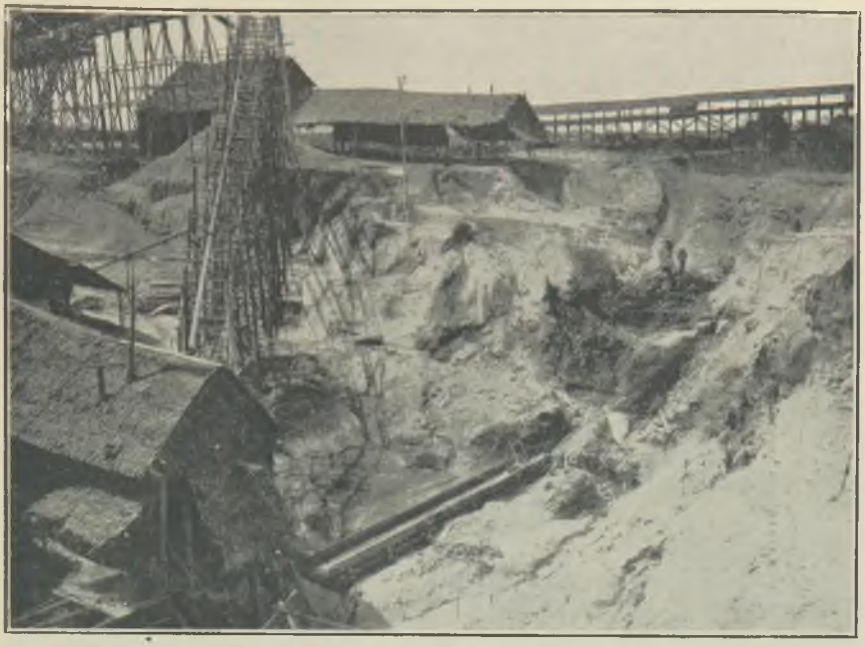


FIG. 3.—DISCOVERY OF PIPE IN SEPTEMBER, 1923. THE THREE COOLIES ARE STANDING ON THE POINT M OF FIGS. 1 AND 2.

described later, where there was a zone of intense shearing.

Some time after the horizontal part (NM) of the pipe had been blasted away, a new outcrop of red oxidized stone was discovered at D, 100 ft. to the south, which, in depth, changed to the sulphide-bearing stone noted in the less-weathered parts at NM. The new ore-body proved to be an extension of the pipe, dipping towards 196° at an angle of about 1 in 4, and, in removing the rich tin-bearing stone, a trench 100 ft. long from D, 20 ft. wide, and 35 ft. deep, had been blasted in the limestone by January, 1925. The pipe was the same as that originally found at NM, lost between M and D because 100 ft. of it had been denuded away.

(To be continued.)

A NEW ORE-DRESSING LABORATORY

By W. W. VARVILL, B.Sc., M.I.M.M.

The author decribes the equipment of a new building to be opened this month at Birmingham University.

Birmingham University has long been recognized as one of the leading schools for the training of coal mining engineers and oil technologists, but it has, in addition, a strong bias towards the study of metallurgy and metalliferous mining. This is only natural, for Birmingham is one of the greatest metallurgical centres in the world and it is obvious that provision should be made in the locality for the training of young engineers in all the arts connected with the metal industry, from mining the ore to the manufacture of the finished product. The university provides a course extending over a period of three years for students wishing to obtain the degree of B.Sc. in Metal Mining, or, should they wish to obtain an honours degree the course is extended to four years. These courses are designed to afford complete instruction in the principles and practice of metal mining, quarrying, mine surveying, and mining jurisprudence, and in connexion therewith the students attend lectures and laboratory classes in the sciences allied to mining.

The fact that many Birmingham graduates occupy responsible positions in the mining industry in various parts of the world, adds interest to a description of the recently completed ore-dressing laboratory at the

university. It is probable that the science and art of ore dressing is one of the branches of a mining engineer's training which can be acquired better at a university school of mines than at a mine, for each individual mine has a plant designed to meet its own requirements, which usually differ in material particulars from those of mines working other ores. This is true when viewed from both a technical and an economic standpoint for such a plant may even be unlike those of neighbouring mines which are engaged on treating the same class of ores. Furthermore it is not the premier duty of the officials in charge of an ore-dressing plant at a mine to instruct students, with the result that the latter are often left to their own devices, and unless their practical experience is based upon a firm foundation of theory they are very liable to carry their early experience to other fields and to apply it irrespective of suitability to other problems, frequently with disastrous financial results. Although a considerable part of the theory of ore dressing can be taught by lectures and bench demonstrations with the aid of the usual chemical laboratory equipment, the student can gain a far more practical point of view if he is able to apply in practice the theory so acquired, by conducting test-runs using the actual machines, albeit on a small scale, which he will meet in his later career.

The University has long been equipped with an ore-dressing laboratory installed about 30 years ago, but as much of the machinery was either obsolete or becoming obsolete and furthermore was built on so large a scale as to render test-runs difficult and intermittent owing to scarcity of ores, this laboratory for some time has served mainly as a museum of machinery available for sketching and dismantling. In designing the new laboratory an attempt has been made to provide machines the dimensions of which retain a degree of practical utility, while their capacity is sufficiently small to allow test-runs to be conducted on parcels of ore weighing a few hundred pounds. In this way it has been possible to provide the student with a miniature plant capable of performing all the main functions of a full-sized mill and at the same time consisting of individual machines which are exact small-scale replicas of those used in modern practice.

Exterior of New Ore-Dressing Laboratory at Birmingham University.

The utility of the new plant, however, does not end with demonstrations of educational value. The plant has been designed with a view to conducting research, and it also may, by special arrangements, be used by mining companies as a pilot mill. With regard to this latter use the University Mining Department feels that the greatest mutual benefit would result if mining companies were to

send their own experts to conduct experiments and run such tests as they require, and that the Department is more likely to benefit in that way than when such tests are conducted by the University staff working alone. For it stands to reason that the latter, although their knowledge of the subject may be catholic, cannot, in the nature of things, possess the same degree of knowledge on any one particular problem as does a specialist who has been concentrating on it for years. Any such arrangements must of course be subject to the University's own requirements, and the use of the equipment must be made under agreed conditions.

Interior of the New Laboratory.

The plant is designed to treat the ores of gold, silver, tin, copper, lead, and zinc, as well as minerals of high and low magnetic permeability. It contains, therefore, in addition to crushing and grinding machines common to all ores, a water concentration section, flotation concentration section, cyaniding section, and magnetic separation section. Practically all the important methods of ore treatment apart from direct smelting which comes within the province of the metallurgist, are thus provided for.

Crushing and Grinding Section.—This consists of a 2 in. by 6 in. Sturtevant laboratory roll jaw-crusher discharging via a chain bucket elevator and worm conveyor onto a two-deck Sturtevant laboratory vibrating screen. The oversize from this screen drops to Sturtevant laboratory crushing rolls of 8 in. diameter and 5 in. face. The rolls product drops to the bucket elevator and returns to the screen. The undersize from the vibrating screen drops to the feed scoop of a 24 in. by 8 in. Hardinge conical ball-mill and the mill product goes via a Dehne diaphragm pump to a 10 ft. Dorr classifier. The oversize from the Dorr classifier can be returned to the mill or run to the sand shaking table.

Water Concentration Section.—This consists of a three-compartment Hartz jig, a Richards pulsator jig, and two Deister shaking tables, one of which is ribbed for sand and the other for slimes. The Hartz jig, the compartments of which measure $8\frac{1}{2}$ in. by $5\frac{1}{2}$ in., has a 4-speed variable-drive pulley and variable-stroke eccentrics. It is equipped for jigging over the sieves and has central concentrate draw tubes. The Richards pulsator jig has one compartment and is intended for close-sized jigging tests. The jig feeds are taken from the oversize of the lower vibrating screen. The two shaking tables measure 3 ft. by 1 ft. 6 in. and run at 260 strokes per minute. The feed for the tables comes from the spigots of two hindered-settling cone hydraulic classifiers which take the sand discharge of the Dorr classifier. The overflow from the hydraulic classifiers returns to the Dorr classifier.

Flotation Section.—This consists of an 8-cell sub-aeration Minerals Separation machine with cells 8 in. by 8 in. by 9 in., the

impellers running at 1,600 r.p.m. This can be modified for use in differential flotation processes. The flotation feed comes from the overflow of the Dorr classifier. The flotation concentrate is pumped to the Dorr thickener for dewatering and thence, via a Dorrco pump, to a Dorrco vacuum filter.

Thickening and Filtration.—A 5 ft. by 4 ft. Dorr thickener with automatic overload device has been provided and can be used for several purposes :—

(i) Thickening flotation concentrate prior to filtration.

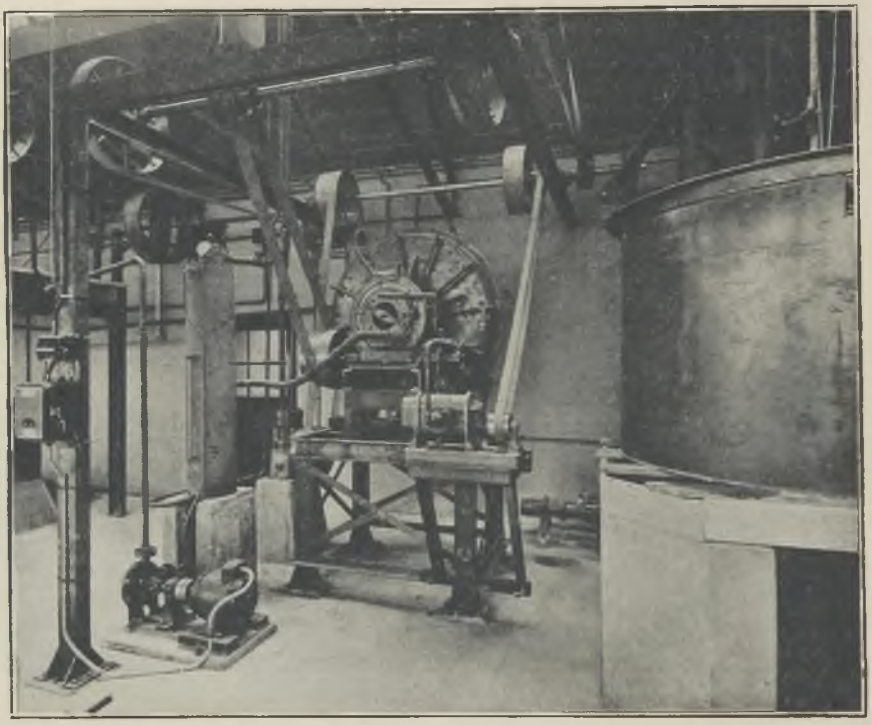
(ii) Thickening classified slime for table feed.

(iii) Thickening classified slime for agitation with cyanide.

(iv) Dewatering flotation tailings.

The Dorrco filter is of the continuous rotary-drum vacuum type, which takes the feed into the interior of the drum and thus utilizes the force of gravity to assist, both in forming the cake, and in the removal of the cake from the cloth. This arrangement obviates the agitation of the feed pulp, which is necessary with external-feed drum filters of the Oliver type. Vacuum is provided by an Ingersoll-Rand vacuum pump and the air blow for cake removal is supplied by a small Oliver and Onions blower. Liquid is removed from the filtrate receiver by a small motor driven centrifugal Gwynne pump.

Cyanide Plant.—A small cyanide plant made by Fraser and Chalmers enables experiments to be made on gold ores. Provision is made for leaching sand from the Dorr classifier or agitation in cyanide of thickened slime from the Dorr thickener, or, as an alternative, it is possible to take an unclassified mill product direct to the agitation tank. The plant consists of a 3 ft. by 3 ft. sand leaching tank and a $4\frac{1}{2}$ ft. by 5 ft. mechanical agitation tank provided with a central air lift and distributor arms. The cyanide solution is kept in circulation by a Gwynne motor-driven centrifugal pump drawing from two sump tanks and discharging via the leaching and agitation tanks to a filter box and three zinc extractor boxes. For filtering and washing the slime residue there is a 12 ft. plate filter-press filled by two montejus, one for slime and one for clean water. The slime is pumped to the plant by a Wilfley sand pump.



Closer View of Part of the Plant.

Flotation Cells and other Equipment in the New Laboratory.

Magnetic Separator Section.—Two machines are provided, one of the low intensity drum type for treating dry magnetite ores, and one high intensity "Rapid" magnetic separator with two discs for treating feebly magnetic ores. Both were manufactured by the Rapid Magnetting Co. of Birmingham.

Auxiliary Plant.—A full equipment of sample grinders, sieve shakers, balances, flotation testing machines and other laboratory plant is provided, and the assay and chemical laboratories of the University are readily accessible for analytical work. In addition the laboratory has attached to it a well-equipped machine shop and the comfort of operators has been provided for in the shape of a changing-room and shower baths. The entire plant is electrically driven and lighted and steam heated. Electric current both a.c. and d.c., gas, water and compressed air are laid on. Power is provided by 1-14 h.p. squirrel-cage G.E.C. motor for the flotation and grinding sections, and 1-10 h.p. slip-ring motor (G.E.C.) for the crushers, rolls, jigs, tables, and magnetic separation plant, in addition to several small motors attached to direct driven pumps. The plant is housed in a building of appropriate design which is shown in Fig. 1.

This ore-dressing laboratory, together with the coal-treatment and the mining-machinery laboratories, already opened, completes the re-construction programme of the University Mining Department which was inaugurated in 1925 by Professor K. Neville Moss, the Head of the Department.

The Association of Scientific and Technical Institutions.—The report of the Council of Management of the Association of Scientific and Technical Institutions was adopted at the statutory meeting held this month at Burlington House, when Sir David Milne-Watson presided. The report refers to the appeal for a central building which was made to members of the constituent institutions in February last, when it was mentioned that it would be necessary to secure £100,000 in cash by June 24 in order to complete the purchase of the Westminster site. The sum available at that date fell considerably below the required amount and the options on the leases were allowed to lapse. The acute financial conditions prevailing have rendered it necessary to postpone making a national appeal.

BOOK REVIEWS

The Geology of Malaya. By J. B. SCRIVENOR. Cloth, octavo, 217 pages, illustrated. Price 16s. London: Macmillan and Co.

This is a companion volume to the "Geology of Malayan Ore-Deposits" by the same author published in 1928. These works, together with Prof. Brouwer's "Geology of the Nederland East Indies," published in 1925, provide a complete survey of the geology of the East Indian Archipelago, an area which, from its proximity to the ancient "Gondwanaland," its situation on the margins of the largest continental mass, close to a notable line of vulcanicity and instability, is of outstanding interest to the student of world geology. All who have worked in moist tropical climes will appreciate some of the difficulties of the author and his staff in elucidating the geology and correlating the strata of Malaya with those of surrounding districts. The heavy mantle of vegetation and consequent paucity of exposures, the intense nature of rock weathering due to heavy tropical rain and low run-off, render geological research here extremely difficult. This is attested by the conflicting opinions which have been expressed in the past on Malayan geology. The orogenic systems of Asia here undergo marked changes of direction, and the tectonic history of Malaya presents problems of profound difficulty. The tectonic student will follow with interest the first chapter of the edition and doubtless will regret that the author has not devoted more space to this question. The degree of metamorphism shown by rocks in Malaya, both regional and contact metamorphism, has rendered many of the problems almost impossible of solution. In view of these difficulties, the author is to be congratulated on the readable account he has presented and for the geological map in colour provided loose in a pocket in the binding. This will be invaluable to workers in Malay.

Those who have followed the discussions on questions of Malayan geology, which have from time to time appeared in articles and correspondence in the MAGAZINE, will doubtless regret that the author has not given these interpretations more space. They are disposed of in three pages of the introduction. The admirable bibliography in Chapter XIII, however, will enable those interested to delve deeper into the problems. The chapter on "weathering" is the best in the edition and its study will give the general reader a ready appreciation of the causes of the diversity of views held on Malayan occurrences. The author very wisely emphasizes the importance of "being sure what people mean when they use the term laterite." It is worthy of note that Malay, an undoubted tropical country, does not provide evidence to support either the theory that the end product of the tropical weathering of felspar is aluminium hydrate, or the theory that laterites are due to alternations of wet and dry seasons. The author's finding that "the production of aluminium hydrate or kaolin does not depend on climate, but rather on the basicity or acidity of the rock and the composition of the felspars" is entirely in accord with the reviewer's experience, not only in the East Indian Archipelago, but also in India and Africa. The only criticism one can make of this chapter is that the author has not emphasized and illustrated sufficiently the extensive nature of the weathering of the limestones in Malay. It is this feature of Malayana physiography which has probably been responsible for the varying interpretations of relationships and sequence brought forward. In addition, the treatment of the metamorphism of rocks is all too short, and one cannot but think that the part played by "pneumatolysis" has not received sufficient stress. It is well recognized that tin ores are invariably associated with granites, which are derived from magmas rich in fugitive constituents and doubtless many of the examples of "selective" metamorphism described by the author may be explained by this process. The fact that "by far the most abundant minerals formed in the sediments by contact metamorphism are tourmaline, biotite, and actinolite" is surely significant of pneumatolysis, as these are typical hydato-genetic minerals. The absence of metamorphic aureoles round the granite bosses is surely unique, and the inapplicability of Mr. George Barrow's mineralogical temperature gradient in the surrounding rocks, offers scope for further research.

The book is well printed and amply illustrated with photographs, maps, sections, and diagrams. The author has produced an interesting account of a very difficult subject and the only possible complaint may be that it is too concise. The book will be

of interest and value to all associated in the tin-mining industry of Malay, and to all students of world geology.

ERNEST PARSONS.

Secondary Aluminum. By Dr. ROBERT J. ANDERSON. Cloth, octavo, 563 pages, illustrated. Price 45s. Cleveland, Ohio : The Sherwood Press.

Secondary aluminium means aluminium (and aluminium alloys) recovered from scrap metal and from products such as skimmings and dross, which are produced in melting aluminium. The recovery is simply a remelting process. Where refining is attempted, it consists only in removing gases and suspended non-metallic matter from the molten metal before casting. Generally speaking, no attempt is made to remove dissolved (or alloyed) metallic or non-metallic impurities, and therefore the composition of the product is determined by the composition of the raw materials. In the early days of the secondary-aluminium industry, there was no systematic control of the raw materials. Scrap and drosses of any composition were melted together and the resulting light-alloys of unknown composition were marketed as aluminium. The inevitable result was that secondary aluminium came to be regarded with justifiable suspicion. Gradually, however, methods of controlling the composition of the metal by the systematic sorting, grading, and blending of the raw materials, have been adopted, with the result that secondary aluminium is now supplied to specified analyses at a cost about 10% below that of the corresponding grade of primary aluminium and is being used with confidence for most purposes for which aluminium and its alloys are suitable.

In this book the author discusses every branch of the secondary-aluminium industry. The first six chapters deal fully with the raw materials—buying and selling, grading, sorting, and sampling. The following seven chapters deal with the equipment and processes used in converting the raw materials into aluminium-pig and alloy-pig of good quality. The remainder of the book includes a discussion of the cost of production of secondary aluminium, and of the economic position of the industry. There are also chapters on light alloys in general, and on the effect of impurities in the metal.

Throughout the book the author insists on the need of efficient technical control at all points. His thesis is that secondary aluminium, properly made, is thoroughly reliable. The fact that in the United States the annual output of secondary aluminium is now approximately one-third of the total annual production of aluminium, shows that the author's faith in secondary aluminium is widely shared by users. The work is brightly and clearly written, beautifully printed, and nicely illustrated. It can be confidently recommended to anyone interested in aluminium.

M. S. FISHER.

Microscopic Determination of the Ore Minerals. By M. N. SHORT. Paper covers, 204 pages, illustrated. Price 60 cents. United States Geological Survey Bulletin No. 825. Washington : Superintendent of Documents.

The Geological Survey of the United States have published, from time to time, certain notable books of world-wide interest that have become an essential part, not only of geological libraries, but also of the geologist's private collection of authoritative works kept on his handiest bookshelf. Clarke's "Geochemistry" and Larsen's "The Microscopic Determination of the Non-Opaque Minerals," to name only two, are close companions of geologists of all countries. To this select list must now be added "Microscopic Determination of Ore Minerals," by M. N. Short, who has been occupied on this subject for the last four years, chiefly in the laboratories of the U.S. Geological Survey and in the Harvard Laboratory of Economic Geology.

Some measure of the advances made during the last few years in the methods of investigating ore minerals under the microscope may be gathered from the fact that no fewer than five books, dealing specifically with this subject, have been published in the U.S.A. and in Germany ; and that new instruments, specially designed for this purpose, have recently become available. The present book of 204 pages is divided into the following 4 parts : 1. Microscopic technique. This section gives, in 30 pages, full descriptions of the ore-microscope and accessories, of the various methods of polishing the specimen, and of photographing it under the microscope. Part 2 deals in detail with the physical properties of ore-minerals under colour, hardness, and electro-conductivity, and the procedure for testing these properties. The 20 pages occupied by Part 2 are followed

by 57 pages forming Part 3, which contains descriptions of etch reactions and a series of very useful determinative tables. "Microchemical methods" forms the subject matter of Part 4. The 88 pages forming this part of the book summarize clearly and concisely almost all that is known on this part of the subject. Sixteen figures serve admirably to illustrate the subject matter; the figures are supplemented by 11 plates, nine of which are beautifully reproduced in colour to show the results of microchemical tests. Numerous references to important works on the subject, and a useful index, complete a book that is easily the best that has so far been published in the English language on the modern methods of determining opaque minerals under the microscope.

WILLIAM R. JONES.

Firedamp Explosions and their Prevention. By W. PAYMAN and I. C. F. STATHAM. Cloth, octavo, 158 pages, illustrated. Price 12s. 6d. London: Humphrey Milford, Oxford University Press.

Three parts of this book are devoted to describing the official tests employed in Great Britain and the other chief coal-producing countries to determine the flame proofness of safety lamps, electrical apparatus, and explosives used in coal mines, in order to ensure their safe use when employed in atmospheres containing firedamp. Had the title of the book made this plain one would have few criticisms to offer, for both authors are particularly well qualified to write on this subject. The title used, however, leads one to expect much more in the book than is found in its pages. Chapter 1 is most inadequate, for obviously space should have been devoted to the means provided below ground for preventing dangerous accumulations of firedamp. A mere reference only is made to the risk of ignitions of firedamp by the spontaneous combustion of coal or by sparks produced during the working of hand and mechanically (other than electrically) operated appliances. Much useful advice concerning the safe use underground of coal cutters, conveyors, and trailing cables could have been given by the authors. The selection of the title of the book was unfortunate, for had it been "official tests to determine the flame-proofness of mining appliances," or something similar, one could have given the work one's blessing, with the proviso that a few more sketches would have enabled one to understand better some of the test appliances described and that references to the data given on pp. 8 and 9 might with advantage have been given.

K. NEVILLE MOSS.

Electricity for Coal Mining Students. By J. STEVENSON and W. MILLER. Cloth, octavo, 250 pages, illustrated. Price 7s. 6d. London: Crosby Lockwood and Son.

The reviewer would have no fault to find in the substance and text of this little book of 250 pages were it not expressly stated that it is a textbook for students preparing for the Colliery Managers' Examination. This claim detracts from its value. As an elementary book for mining students it is excellent and fills a useful purpose, but it does not cover adequately the ground it claims to do, for there is no specific mention of the use of electricity to drilling, coal cutting, conveying and pumping, except a reference to a protective device for a coal cutter on p. 170. It does not, therefore, give the bare minimum of the present day requirements in electrical knowledge for colliery managers, or alternatively if it does, then the standard of the present Colliery Managers' Examination, which stands also at present for the professional examination of the industry, is much lower than that required in other engineering professions.

K. NEVILLE MOSS.

Mining Electrical Engineering. By Dr. H. COTTON. Cloth, octavo, 307 pages, illustrated. Price 15s. London: Chapman and Hall.

We were under the impression that this book was a revised edition of a book entitled "Electricity Applied to Mining" by the same author. Examination of both works, however, reveals that the book under review is introductory to the older book. According to the author the book has been written with the necessary bias to make it acceptable to the average colliery electrician who is working for some recognized qualification. When he has mastered the book such a man need have no fear in presenting himself for examination.

Well written, and admirably illustrated, the book contains thirteen chapters of which

the first three deal with the electric circuit, power and energy, and magnetism. In regard to the chapter on power and energy it is thought that such matters as load factor, peak load, diversity factor and systems of charging for electrical energy should be introduced. These have a marked effect on a power user's philosophy and well-being. Another suggestion we have to offer is that of including a page or so on the grid system. As it stands, however, there is matter enough in the chapter to make the reader inquisitive.

A chapter on batteries is followed by a group of seven chapters on direct- and alternating-current machinery and bed rock facts are explained in a manner that is likely to be acceptable to all students. It is seldom one finds such a large amount of useful information in an elementary book, and it is evident that care has been taken to ensure accuracy. Chapters on instruments and illumination bring a useful book to a close. We unreservedly recommend Dr. Cotton's book to all electrical students who desire to be well-grounded in engineering principles.

H. H. BROUGHTON.

☞ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C.2.

LETTERS TO THE EDITOR

Chromite in Sierra Leone

SIR,—In connexion with my article on "Chromite in Sierra Leone" published in the MAGAZINE for October—it has been brought to my notice that there is no mention of Dr. N. R. Junner's name as part discoverer of the chromite deposits under review. I much regret this omission, but I am sure everyone connected with West Africa fully appreciates the excellent pioneer work carried out by him and his assistant, Mr. Pollett, in Sierra Leone.

The first discovery of chromite was made by Dr. Junner 30 miles distant from these deposits, and other chromite areas have been located by him in various parts of Sierra Leone. So far as is known at present the deposits reviewed, owned by the United Africa Company, hold out the best prospect of having a commercial value.

W. H. WILSON.

Hove, Sussex.
November 7.

SIR,—I have read Mr. Wilson's article in the October number of the MAGAZINE with great interest. With regard to the statements on page 202 that I found the first chromite as boulders lying on a bush path crossing the Kambui Hills and that further prospecting resulted in the discovery of an outcrop of high-grade chromite and of widely distributed detrital chromite, these while substantially true are apt to be misleading. At the time the discovery was made Major N. R. Junner was Director of the Geological Survey of this country, and I Assistant Geologist acting under his direction. About a month previous Major Junner had made the first discovery of chromite in Sierra Leone near Sendumi, some 20 miles to the south of the occurrences described by Mr. Wilson. On the day this latter discovery was made Major Junner and I were working the track between Kundowahun and Lago. I was ahead and noted small loose blocks of chromite by the side of the track just before the brow of the hill. While I was searching for an outcrop Major Junner passed me and discovered the main No. 1 deposit. Major Junner and I together located No. 3 deposit, while No. 2 deposit, probably the largest of the three, was, I believe, discovered by Mr. Wilson himself. I shall be grateful if you will publish this amplification of the statements in Mr. Wilson's article.

J. D. POLLETT.
Geological and Mines Department,
Freetown, Sierra Leone.
November 7.

NEWS LETTERS

BRISBANE

October 21.

Mount Isa Operations.—The quantity of ore treated at the Mount Isa mill during September was 27,056 tons, which yielded 5,352 tons of concentrates. Compared with the production for the preceding month, this is an increase of 101 tons of ore treated and a decrease in the concentrates of 255 tons. The official returns show that the bullion railed from the mine to the coast for shipment to England contained 2,246 tons of lead, worth £26,793, and 130,302 oz. of silver, valued at £7,601, thus giving a total value of products for the month of £34,394. This compares with an aggregate value of £36,022

for August. The average price of lead for September was £11 19s. 7d. a ton, and of silver 1s. 2d. an ounce. Since then to the middle of October there has been a further rise of a few shillings per ton in the quotations for lead, and of silver 1½d. an ounce. In the mining section of operations at Mount Isa about equal tonnages of average-grade carbonates were during the month drawn from each of the seven Black Star lode glory-holes, which were operated continuously during the period. The surface drainage ditch was continued and nearly finished. In the Black Rock section no carbonates were mined. Alterations were made in No. 1A transfer pass and two chutes were constructed at the main haulage level. At the same time the rise for travelling ways was advanced to 122 ft. The development of the main ore-body was continued by driving sub-levels over the main haulage level. All the ore broken in these drives is being handled by scrapers. By means of short diamond drill-holes from the main haulage level, the extension of the foot-wall body was tested. In the Rio Grande section foundations were made for the electric light hoist at Lawlor's shaft. The stopes on the main lode at No. 1 level were continued on the other two lodes, while stope preparations were continued on the other two lodes. The stoping of sulphides was resumed in the stopes over No. 4 level, north of the Lawlor shaft, and stope preparations south of the shaft have been in progress. The installation of a main suction fan at No. 46 shaft has been completed, and the fan put in operation. At present about 70,000 cu. ft. of air per minute is being drawn through the fan and, as a result, ventilation conditions underground are excellent. The Government inspector of mines (Mr. F. Young) reports that a number of cases of "lead intoxication" were last month reported from the Mount Isa Mines, Ltd., caused chiefly by furnace fumes, but that practically all were of a very mild nature. As the company has its own hospital, all suspected cases receive immediate treatment, by which means the evil is checked before it has time to reach a serious stage.

Cloncurry District.—In the Cloncurry mineral field, apart from Mount Isa activities, a good deal of mining is still being carried on. The chief tribute mines belonging to Mount Elliott, Ltd., have until lately all been in full swing, producing a good tonnage of copper ore. Last month the Mount Oxide mine had an output of about 400 tons, and preparations have been in progress for a greatly increased production. At the mines now held under tribute by Messrs. Powell and Peterson (Mount Oxide, Dobby, and Orphan), however, an intended reduction of wages was notified, but rejected by the men, and these mines have become idle. At Mount Cuthbert several tributers are at work, and one of the parties, working to a depth of 150 ft., is on a nice ore-body. The privately owned Trekelano, near Duchess, which has been employing 50 men and producing copper ore of good quality, has been compelled to close down owing to the low price of the metal.

Gold Mining Development.—The Secretariat Report to the Premier's Conference shows that a definite case exists for a more rapid development of gold mining in Australia, which should lead to a considerable increase of employment. It is suggested that under the extremely serious conditions existing at present ample justification exists for action by the Commonwealth and recommends that the Government appropriate £500,000 for Federal assistance to the industry. This the committee proposes should be used for loans to mining companies, syndicates, or individuals, on the basis of not more than £1 for £1 raised apart from the Government, for the exploration and commercial development of gold-mining properties; for assistance to State Governments where ordinary funds available for Departments of Mines are insufficient; and for the temporary increase of geological staffs for the more scientific direction of prospecting and mining. Prior to this, the Federal Government, in its economy schemes, had reduced by one-half the gold bonus which has been paid during the past nine months. Originally the amount of this bounty was £1 for each fine ounce of gold produced in excess of the average quantity unearthed annually during 1928 and 1929. The advantage to the industry of this bonus has been greatly augmented by the current rate of exchange. From Western Australia, however, it has been represented that the later reduction of the bounty was a great blow to the industry in that State and the Federal Government has now decided that the bonus shall be automatically increased from 10s. an ounce for every 3% drop in the Exchange rate.

Canoona Goldfield.—A short time ago a mild sensation was caused by the discovery of a very rich patch of gold in the vicinity of the old Canoona goldfield, in the Central

district of Queensland, where gold was first discovered in what is now the State of Queensland but what was then a part of New South Wales. In one way history is now repeating itself. In the early discovery the first reports were so good that a great rush took place from all over Australia and even from New Zealand, but the deposits first discovered soon petered out, with disastrous results to hundreds of men. Now a Government geologist has turned the light of science on to the latest find and, after a careful examination and sampling, says the deposits are very low in grade and that there is little hope of any important development in the locality. Old miners, however, who are apt to scoff at geologists and still believe the old adage regarding gold that " where it is, there it is," continue to fossick in the neighbourhood, and some are getting small amounts of gold-impregnated rock, sufficiently valuable to find them in " tucker." They remember that the original Canoona, after the earlier failure, gave great returns.

Australian Shale-Oil Industry.—In this column last month it was stated that work had been resumed by the Shale Oil Development Committee, Ltd., in the Newnes Valley, New South Wales, after the field had been closed nearly eight years. It is now announced that an agreement to amalgamate certain shale-oil interests in Tasmania has been ratified by shareholders in the Tasmanite Shale Oil Company, Ltd., in Melbourne. This company will take over the property of Railton Lathrobe Shale Oil Company, Ltd., the shale-oil interests of the Goliath Portland Cement Company, Ltd., as well as those of Mineral Oils Extraction, Ltd., and the shale property of Mr. F. Richards. The Crozier shale retort is to be used. The authorized capital of the Tasmanite Company is £250,000. If the Crozier retort proves a success after a further trial, which it was expected to complete in two months, the public is to be asked to subscribe to an issue of 100,000 shares of £1 each. The patentee of the Crozier retort and process (Mr. R. H. Crozier) states that 200 tons of crude oil already has been extracted from 2,000 tons of shale by his process. As soon as possible after the ratification of the amalgamation agreement it is intended to improve the present retort and refining plant, which was expected to be brought to a capacity of 30 tons of shale oil a day, and on which basis it is anticipated the unit will be self supporting, while any increase in the quantity treated will yield a small profit. It is anticipated that ten more retorts, making 16 in all, will be started at an early date, so that possibly within a month's time 120 tons of shale oil will be put through daily. Already overseas orders have been received and 150 tons has just been dispatched to Britain to the order of Babcock and Wilcox, Ltd.

New Guinea Prospects.—The Administrator of the Mandated Territory of New Guinea (Brigadier-General A. E. Wisdom), who passed through Brisbane lately on his way south, expressed the opinion that within a few years New Guinea will be a prominent gold-producing country. At Bulolo and Edie Creek, he said, several claims are being worked and more large companies are directing attention to New Guinea, where gold would ultimately be mined in large quantities. Some four or five companies are already preparing for intensive work on the Bulolo field. Batteries and other units are being erected, all of which had to be carried in small sections from the coast by air. The latest report from Bulolo Gold-Dredging, Ltd., is that its No. 1 dredge is more than half completed. All the machinery and material, amounting to 705 tons, have been transported from the coast to the field by air. Boxing with native labour, for production on a small scale on one of the company's leases, has already begun.

JOHANNESBURG

November 5.

Carolina Goldfield. — Encouraging reports have been received here concerning the outlook for the Carolina District goldfield, in the Eastern Transvaal. A Johannesburg syndicate has found good values on the farm Weltevreden No. 84, which lies to the dip of Slaaihoek No. 153, on which a large highly honeycombed quartz reef is being worked by the Slaaihoek Mines, Ltd., a Pretoria company. It is stated that the reef as developed in Slaaihoek varies considerably in width from 24 in. to 100 in. It may not be payable everywhere, but the Slaaihoek management mines everything as it is found, and at 90% extraction the recovery per ton is 8½ dwt. The cost is only 15s. per ton, and the profit is approximately £3,000 per month on a crushing basis of 2,700 tons a month. To the north-west of Slaaihoek is Mamre No. 84, on which the Mamre Gold Mining Company has erected a reduction plant

which was placed in commission in June last. The company's report for the quarter ended June 30, 1931, stated: "During June 1,400 tons of development rock and ore from stopes was crushed, with an average value of 5·8 dwt. No reliable figures as to recovery and extraction are yet available, due to the limited tonnage of ore crushed. The development footage carried out during the quarter in the faulted area, mentioned in the previous report, amounted to 42 ft., of which 20 ft. of reef has so far been exposed. The average value is 5·7 dwt. over 41 in. On Weltevreden No. 84, the Johannesburg syndicate's property, the reef has been exposed by short adits driven into the steep slope of the mountain for over 2,000 yd. and it is indicated for a further distance. The dip of the reef is towards the south-west and varies from a few degrees to between 10 and 15°.

Barberton District.—It is reported from Barberton that mining activity in the De Kaap fields is steadily increasing. Representatives of British or Canadian firms have secured options over certain promising properties and large numbers of additional claims have been pegged. Engineers who have visited the fields recently are said to have expressed the opinion that if certain properties were properly equipped and supplied with sufficient working capital, the gold output of the Barberton district would soon be greatly increased.

Low-Grade Ore Problem.—Giving evidence before the Low Grade Ore Commission, Sir Robert Kotze, who was government mining engineer for many years and chairman of the Low Grade Mines Commission, 1921, expressed the opinion that if low-grade ore is to be rendered workable to a larger extent than is at present the case, the yield must be raised or working costs must be reduced—or both. The natural yield, Sir Robert said, cannot be increased, being fixed by the amount of gold in the rock, but it can be artificially increased by a subsidy. For example, a subsidy of 2s. a ton would raise a 14s. grade to 16s. a ton and might make such a grade workable. In low-grade ore he would include ore lying fallow, either in mines which had been worked or opened up in the past but abandoned as unpayable, or in areas which have not been opened up at all owing to their being considered financially unattractive. Sir Robert pointed out that for every ton of rock worked at an average cost of about 20s. a ton the State benefits to the extent of 3s. 2d. It would thus obviously be to the State's advantage to pay, say 1s. a ton to have that ton of ore worked rather than to have it remain untouched.

Lower Costs and Longer Life.—A technical sub-committee of the Gold Producers' Committee of the Transvaal Chamber of Mines has submitted to the Low Grade Ore Commission a statement which shows that if the working costs per ton can be reduced by 4s. the "life" of the Witwatersrand fields will be more than doubled. The results of the sub-committee's calculations provided the following conclusions:— 1. After adding 20% to the official lives of the existing 34 mines, the total tonnage to be milled from the beginning of 1931 for the whole of the Witwatersrand would be 335,000,000 tons under existing conditions of costs. 2. A reduction of 2s. per ton milled in working costs and yield would mean that an additional 112,000,000 tons were likely to be milled, an increase of 33% in the total tonnage and, therefore, in the average life. 3. A reduction of 4s. per ton milled in working costs and yield would mean that an additional 243,000,000 tons were likely to be milled beyond the 335,000,000 under existing conditions, an increase of 72% in the total tonnage, and therefore in the average life. These estimates cover 67,500 claims, and take no account of any new areas which may be opened and of no tonnage below about 7,500 ft. A very large amount of additional tonnage over and above that referred to in conclusions (2) and (3) would become available with a reduction of costs. Taking these considerations into account, the committee believes that, if working costs and yield were reduced by 2s. per ton milled, there would be an increase of at least 50% in the future average life of the Witwatersrand, and that, if working costs and yield were reduced by 4s. per ton milled, the future average life of the Witwatersrand would be more than doubled.

Costs and Deeper Mines.—It appears that whatever beneficial effect a reduction in the general level of working costs might have on the mining of low-grade ore in other mines and in mining such ore from other reefs, there can be no doubt but that a substantial reduction in working costs would bring about the mining from deep mines of a much greater amount of ore, low-grade and otherwise, than is now within the bounds of possibility. In considering this problem of deep-level mining, one of the points which

must be borne in mind is that, unless such of the existing mines as may be said to have unlimited depths before them can be induced to extend their workings into these depths, it is a practical certainty that many years, if not many generations, must elapse before any body of men will even think seriously of commencing new mines for the exploration of these depths.

Manganese Corporation (1929).—The Manganese Corporation (1929) announces that pending the clearing up of the international exchange position, and more particularly the South African exchange, delivery orders on current contracts are being withheld. The corporation having sufficient stocks on hand to meet any urgent orders, has decided to stop production at Postmasburg until the position is clearer. Negotiations with interests in other parts of the world—both with the object of manufacturing ferro-manganese in this country and for the shipment of manganese ore to other parts of the Empire—are still being carried on, although of necessity the present crisis will delay their progress.

IPOH

November 19.

The Budget.—The meetings of the Federal Council in Kuala Lumpur have been occupied with the budget of the F.M.S. for the year 1932 and with explanations by the High Commissioner of his recently announced policy of decentralization. The mining industry is inevitably affected, directly or indirectly, both by taxation, and by such changes of policy as are proposed, and every detail of these changes should be examined very carefully by all the senior and experienced men engaged in the industry. The endeavour to foresee consequences should not be left to only a few, who are officially obliged to show that some consideration has been given. With regard to the estimates it is of interest to note that the average trade balance in favour of the Federation during the seven years of plenty —1923 to 1929—was 167 millions of dollars a year, while the latest quarterly returns indicate a total of only 17½ millions excess of exports over imports for the current year, which is the lowest balance recorded since 1908. In the same seven years the average price of tin was £246 4s. per ton, and of rubber 1s. 6d. per lb. The prices to-day being respectively £133 5s. and 3d., and export duties being on a scale graduated according to the prices current, it is evident that the loss of revenue by the combined effects of depreciated values and of restriction must be almost calamitous. In this connexion it is of interest to note that there is a proposal for a Malayan Customs Union which would be profitable to the F.M.S., but for the complete success of which the entry of the Straits Settlements would be essential, because the two chief ports of the peninsula—Singapore and Penang—are in the Colony.

Decentralization.—To those long resident in this peninsula the existing organization for government is familiar, and on the principle that the ills we know are generally to be exchanged with caution, if at all, for those we wot not of, the miners must see to what results the new proposals will lead. Kuala Lumpur has the acknowledged advantages that it is geographically central and convenient for communication with most of the states. Miners in Selangor have been specially fortunate in the facility and despatch with which urgent business with Government Departments could generally be transacted. On the other hand Perak and in particular the Kinta mining field has suffered long, though by no means silently, under the inconvenience of having to refer much if not most of even routine business to Taiping—about 55 miles distant—where in the normally tranquil atmosphere of a small country town the exigencies of affairs at a distance could not obtrude themselves too insistently, and in special cases to Kuala Lumpur afterwards. For legal and other professional and commercial business Ipoh has been for long the active centre in Perak, but even in its own district it has been put to the costly inconvenience of having to refer a very large proportion of mining business to Batu Gajah, 12 miles away by a very tortuous and busy road, where the Warden of Mines Perak is established, and the Kinta district Land and Survey offices. The F.M.S. Geological Survey is also established in Batu Gajah, and its usefulness has without question been seriously prejudiced by its being out of a commercial centre. The loss of time and the inconvenience caused by these, for the public, most unfortunate locations is now recognized, and it is admittedly the policy of Government to move its headquarters in Perak to Ipoh,

but the present need to economize in every way has resulted in the moves to Ipoh being deferred.

Restriction.—It is expected that the procedure in the F.M.S. at the end of the present quota period (end of November) will be similar to that at the end of August, and the precise measure of the cut will not be determined until the figures of production from all parts of the country are available.

For Siam (according to the *Bangkok Times*) the Minister of Lands and Agriculture has notified that the term of the first quota period is fixed at six months from September 1.

	Tons.
Reserved for tin in possession .	542·8
,, ,, production by holders of washing licences .	500·0
Total . .	1042·8

After deducting this total of 1042·8 tons from 10,000 tons, which is the accepted total annually exportable by Siam, there remains a balance of 8,957·2 tons, which will be apportioned to producers to be mined for the whole year from September 1. The total of Assessments for those who have applied for Certificates of Production amounts to 12,868·2 tons, which total exceeds the amount to be allotted to producers by 3,911 tons. The minister has therefore fixed the quota for the first quota period at 69·5% of 12,868·2 tons, which results in a restriction of 30·5%.

VANCOUVER

November 9.

Great Bear Lake.—The announcement in the summer of 1930 of the discovery of pitchblende of exceptionally high radium content and of high-grade silver ore at Great Bear Lake, in the North-west territories, aroused considerable public interest. This year other very promising discoveries have been made in the vicinity and in view of the possibilities prospecting parties were sent into this field by such concerns as the Consolidated M. & S. Co., Northern Aerial Mineral Explorers, Dominion Explorers and others. During the summer the area was visited by Mr. Hugh S. Spence, Mineral Technologist of the Canadian Department of Mines, whose conclusions have been incorporated in the form of a memorandum recently issued by the Department. The region was far from readily accessible until the advent of the aeroplane, but now the journey from Waterways, the nearest rail terminal, to reach which formerly occupied about four weeks under the most favourable conditions, can now be made if the weather is good, in a single day. All of the present known pitchblende-bearing ground is in the neighbourhood of the original discovery at La Bine Point. The distance between extreme points has recently been extended to about two miles by a find of high-grade pitchblende at that distance along the strike from the shore of the lake into which all the veins pass. Specimens of the ore assayed last Spring by Dr. Boomer of the Department of Chemistry of the University of Alberta and yielded 182 milligrams of radium to the ton, giving the ore, at the present price of radium, a gross value of approximately $9,000 a ton. The pitchblende is found in persistent veins, within or along the contacts of what seem to be highly sheared and often brecciated greenstone bands, which are usually narrow (10 to 20 ft.) but occasionally reach 50 ft. or more. They are almost vertical, have a very persistent strike, and occur at frequent intervals at from 50 to several hundred ft. apart along the lake shore. Of these sheared bands at La Bine Point four have been found to carry pitchblende veins. To date prospecting and development has been confined chiefly to two veins and little attempt has yet been made to explore others. Mr. Spence considers that there is every evidence of the existence at La Bine Point of an extensive and fairly closely spaced pitchblende vein-system that can readily be exploited by underground development. Of the two veins that have been prospected one known as the No. 1 vein is the site of the original discovery and can be traced for several hundred feet. No. 2 vein strikes approximately parallel to No. 1 at a distance of about 500 ft. and has been followed for a distance of 1,400 ft. At present, the No. 2 vein is the most important occurrence, the more so, by reason of the fact that it carries rich silver ore for a part of its length with the pitchblende. The silver discoveries so far have all been made in the Echo Bay section, the principal find being at La Bine Point, where the metal was first reported, on a group of adjoining claims to the North-East and on the Bonanza claims 6 miles to the south. The most important occurrence found to date is on the

easterly 200 ft. section of the No. 2 pitchblende vein at La Bine Point. As indicating how rich some of the surface ore here is, Mr. Spence states that a block of 40 lb. weight, in large part silver, was shipped out last summer.

Coal Mining.—The depressed condition of the coal mining industry in the province has been very marked during the present year. This is evidenced by the production returns for the nine months ending September 30, which show an average decline for all the collieries of the Province of 13%. The most serious falling off, however, was in the Vancouver Island field with a decrease of 19% as compared with a decrease of 8% in the Crows Nest district and of 4% in Nicola-Princeton field. There have, however, been signs of late of an improvement in the situation. This is ascribed to two causes, one being the assistance given the industry by the provisions of the National Fuel Policy, and the other, the advantage derived by those collieries marketing a part of their product in the United States by the fall in Canadian exchange in New York. To aid the collieries of Vancouver Island, a subsidy of 25 cents a ton was granted on all bunker coal and on coal exported to countries other than the United States. This subsidy, however, proving to be inadequate to achieve the desired purpose, was increased last month to 50 cents a ton for bunker coal and to $1.00 a ton on export coal. The effect, it is believed, will be to increase the output of the Vancouver Island collieries to the extent of at least 50,000 tons, and possibly 100,000 a year, which will very materially relieve the present unemployment situation at the collieries.

Yale District.—A meeting of shareholders of the B.C. Nickel Mines, Ltd., was held here early this month at which the directors were authorized to provide for an issue of debentures to the amount of $625,000, to be used for the purposes of working capital if required. To date exploratory work, including diamond drilling and a geophysical survey, has resulted in indicating considerable bodies of massive nickeliferous pyrrhotite occurring in a wide basic dyke intrusive into granite. In his report last year, the District Resident Engineer, Mr. H. G. Nichols, stated that while an estimate of the economic importance of the property can only be obtained as a result of extensive underground development, the work which has been accomplished so far has been sufficient to show that there are here extensive bodies of nickel-bearing mineral.

Boundary District.—Much interest has been created by the results attending the development of a new ore-body carrying very high-grade gold values in small lenses at the Union Mine, situated 45 miles from Grand Forks on the Granby River. This mine was acquired a few years ago by the Hecla Mining Co. The original ore zone, from which shipment of crude ore had been made, was developed by four tunnels. This ore-body is an irregular silicified zone, which on the outcrop carried higher values in silver than in gold. It is, however, practically depleted, as no appreciable tonnage of ore has been found much below the No. 3 level. The new high-grade ore was encountered in a cross-cut 300 ft. south of No. 2 tunnel, in a silicified zone containing small rich lenses. The ore is a heavy sulphide complex, consisting of galena and zinc blende, together with some chalcopyrite and pyrite. Fine free gold is present and assays running up to thousands of dollars to the ton have been obtained.

Bridge River.—At the Lorne the erection of a 100-ton mill and the installation of a hydro-electric plant is in progress. For the latter, machinery has been purchased which was formerly in use at the Cork-Province silver-lead property, near Kaslo. Work on the Forty Thieves claim owned by Bridge River Consolidated is being carried on by two crews under contract. A report has just been received by the company that the main vein has been reached in a cross-cut that is being driven at a depth from the surface of 300 ft.

Portland Canal.—For some months past the smelters both at Anyox and at Tacoma, Wash., have been operating on considerably reduced schedules. This has limited the quantity of siliceous ore they are prepared to accept, and consequently has had the effect of curtailing ore shipments from the Premier. The mine, however, has been operating steadily and, even under present circumstances, is believed to be earning its dividends, which continue to be distributed regularly each quarter. Last month the necessary financing was arranged to enable development operations at the property of the Georgia River Gold Mines, Ltd., in the Georgia River section to be resumed.

TORONTO

November 16.

Porcupine.—During October the seven producing mines in the Porcupine area milled 262,267 tons of ore, yielding bullion to the value of $1,671,035, as compared with $1,981,624 for September from 258,038 tons. The Hollinger Consolidated, during the three months ending September 30, produced gross bullion of the value of $2,784,317, a gain of $584,932 over the preceding three months. Other income amounted to $153,736, bringing total earnings for the quarter to $2,938,054. Operating expenses amounted to $1,854,495, leaving a net profit of $1,083,559. For some time past ore has been drawn largely from the surface deposits and high-grade ore has recently been opened up in this section. Better ore conditions are also developing underground. From 3,850 to 4,000 ft. a new mine is opening up with ore values running well above those obtained from the 2,000 to the 3,850-ft. levels. Mill heads are now much higher than they were in the second quarter of the year. Dome Mines during the month of October produced bullion to the value of $285,733 from the treatment of 45,300 tons of ore, the average recovery being $6·31 per ton. The company is building a new mill addition in order to revert to the old method of amalgamation and cyanidization. It is believed that when the new process is put into operation Dome will be more successful in the treatment of its coarse gold, extraction becoming higher and tailing loss lower. The production of the Vipond Consolidated for the fiscal year ended July 31 was valued at $712,856 from 107,290 tons milled, with a recovery of $6·64 per ton. This compares with production of $896,950, average recovery of $7·91, and 113,329 tons milled the preceding year. Underground development continues favourable. Good ore has been located in the east drive on the 1450 ft. level and fair values are also being obtained on the west drive on this level. The Coniaurum is planning to deepen the main shaft from 2,000 to 3,000 ft. At present work below the 2,000 to 2,500 ft. is carried on through a winze situated some hundreds of feet west of the main shaft. The new vein at the 2,500-ft. level now shows a length of over 100 ft., with an average width of 6 ft. and values higher than on the upper levels. A rise put up 60 ft. above the level is in $15 ore. The Canusa is carrying on an active development campaign and the mill is showing excellent results, ore from the dump yielding $15 per ton. As soon as an adequate supply of power can be obtained both mine and mill will be operated on a 24-hour schedule and it is anticipated that the returns will be sufficient to finance operations.

Kirkland Lake.—The production of this district for October exceeded that of the Porcupine field and amounted to $1,981,182 from 151,982 tons of ore compared with $1,781,573 from 145,956 tons of ore milled during September. Developments of outstanding interest continue to be a feature of work at the Wright-Hargreaves. Results obtained on the levels from 2,250 to 2,700 ft. showed general improvement over those on the levels above. According to the latest official advice the cross-cut on the 3,000 or bottom level has passed through an ore section with the vein running to a width of 7 ft., which has returned values of $30 to $40 in gold per ton. A new crushing plant with a capacity of 1,500 tons a day will shortly be in operation, which will enable the mill to treat a larger tonnage of ore. The annual report of the Teck-Hughes for the year ending August 31, 1931, showed a net operating profit of $3,649,958, as compared with $3,326,313 for the preceding year. The mill treated 396,200 tons of ore, recovering bullion to the value of $5,973,120 or $15·08 per ton. The surplus was $3,311,159, out of which dividends amounting to $2,876,786 were paid. The campaign for carrying the workings to deeper horizons is being actively maintained. The Lake Shore during the fiscal year ending June 30 reports net earnings of $4,505,601 and the production of bullion to the value of $9,152,935, which with returns from other sources brought the gross income up to $9,199,665. Total operating costs amounted to $4,694,064. A supplementary report for the quarter ending September 30 shows bullion production of $2,780,759, and a total income of $2,891,549. The mill is now handling ore at the rate of 2,400 tons per day, with a monthly production of approximately $1,100,000. Equipment is being installed for the purpose of reducing tailing loss, the experimental plant put in some time ago having proved quite successful. Equipment is also being put in place for the concentration of gold tellurides. At the Kirkland Lake mine effort is being concentrated on exploring and developing the levels already established, with encouraging results. In the

more recent sections opened, values are stated to run about $30 to the ton. Barry-Hollinger Gold Mines is steadily increasing its ore reserve, ore on the lower workings showing improvement in grade. The winze from the 1,875 to 2,000 ft. is in ore averaging better than $20 in gold per ton. At the Bidgood a new ore section has been located on the 500-ft. level which is stated to show high gold values. On the 300-ft. level of the Moffatt-Hall channel-sampling showed values of $18·40 over a width of 5 ft. The average grade of ore for the entire length of the drive is reported at about $10 to the ton in gold. The shaft is being put down to a depth of 450 ft. The shaft at the Sylvanite is now down more than 2,700 ft. with an objective of 3,000 feet. When the 3,000-ft. level is reached several new levels will be opened up. In the north workings ore has been developed or placed in sight on all levels from the 200 to 1,762-ft. horizon. A substantial tonnage of ore has been opened up at the 400-ft. level.

Sudbury District. — The Falconbridge Nickel Company during the three months ending September produced 2,038,669 lb. of nickel-copper matte, from the treatment of 30,956 tons of ore, which compares with 1,933,661 lb. from 23,900 tons of ore during the previous quarter. Nickel matte produced totalled 1,462,041 lb. and copper matte 576,628 lb. Prospecting for gold has recently been very active and is likely to be continued throughout the winter as new camps are being opened up. Attention was at first attracted by an important discovery in Swayze township, where a large area has been staked. The Consolidated Mining and Smelting Company has taken an option on 12 claims covering the original discovery and sent in a working crew. Rich gold finds have also been made in the Three Duck Lake area. The entire field extending from Rollo and Denyes townships in the north-west to Chester, St. Louis, and Nelville townships in the south-east—a distance of over 50 miles—will come into a period of intensive prospecting during the coming year.

Rouyn.—Noranda Mines, Ltd., according to an estimated operating statement for the nine months ending September made a net profit of $2,405,813 as compared with $3,842,115 for the 12 months of 1930. The value of the gold and silver production exceeded that of the copper output. Exploration work during the present year has resulted in the proving by diamond drilling and the raising of approximately 60,000 tons of ore averaging $35 per ton in gold and 2·4% copper at the westerly end of the H ore-body between the 100 and 400 ft. levels and the indicating by diamond drilling of about 750,000 tons of fluxing ore averaging over $4 per ton in gold in the G ore-body situated east of the main diabase dyke. No. 3 shaft has been deepened from 2,000 to 2,500 ft., and the sinking of No. 4 shaft to the same depth will be commenced immediately. The Amulet Mines, Ltd., showed a profit of $65,519 for the fiscal year ending June 30 during which the mill was in operation for four months from July 1 to October 20, in which time it treated 38,218 tons of ore of an average grade of 4·10% copper, 16·32% zinc, 0·021 oz. gold, and 3·25 oz. of silver. The production was 7,420 tons of copper concentrate, averaging 16·31% copper, and 9·199 tons of zinc concentrate, containing 52·71% of zinc. The Siscoe Gold Mines during October produced $67,110 from the treatment of 5,394 tons of ore establishing a new record for the month. The shaft will be deepened and two new levels opened up at 725 and 850 ft. The Granada is preparing for operations on a considerably extended scale and has ordered new equipment which will increase the capacity of the mill from 70 to 150 tons daily.

Patricia District.—The mill of the Howey Gold Mines is operating steadily, the production of bullion in October being given approximately at $81,000. New equipment is being installed which will enable an increase in production next year. About 900 tons of ore are being taken out daily, which, after the waste rock has been sorted out, leaves between 700 and 800 tons for treatment. Development work at the Casey Summit Gold property at Summit Lake is proceeding satisfactorily. The drive on No. 2 vein on the first level for a length of 140 ft. returned assays of $18·15 per ton in gold over a width of 3 ft. The south face of the drive is in still richer ore. There is much activity in prospecting in the Little Long Lac section where an apparently important gold strike east of Jellicoe attracted much attention, about 170 claims having already been staked. McChesney Gold Mines, Ltd., has been organized to develope the McChesney property consisting of 15 claims located on the northern arm of East Bay in the Red Lake area, where important finds have been made.

PERSONAL

R. Allen has left for the Gold Coast.

H. Foster Bain has been appointed managing director of the Copper and Brass Research Association of New York.

W. E. Barron is home from South Africa.

J. C. Bolsover is returning from India.

R. P. Brodie has returned from Nigeria.

Stanley C. Bullock is returning from East Africa.

G. Finlayson is returning from India.

H. F. C. Greenwood has returned to Malaya from Borneo.

H. T. Gordon has left Japan for New Zealand.

James Jackson is returning from Siberia.

R. Underwood Jarvis is home from the Gold Coast.

J. Jeffery has left for Spain.

George F. Laycock is returning from Newfoundland.

Percy E. Marmion has left for Burma.

W. McAuliffe is returning from Nigeria.

J. D. Mead is home from Malaya.

Arthur E. Page is returning from Venezuela.

Reginald S. H. Richards has returned to Portugal.

James Roberts is returning from Italy.

E. G. Thompson has returned from West Africa.

W. E. Thorne is leaving shortly for Colombia.

O. A. L. Whitelaw, who retired from the Gold Coast Geological Survey last month, received a parting gift from his colleagues on the Survey, the presentation being made by Sir Albert Kitson.

Bruce C. Davey, vice-president of the Denver Equipment Company, died very suddenly on November 4, at Chicago, following a heart attack.

William David MacKay died in Toronto on November 8, aged 76. He was one of the early pioneers of the Yukon territory, where he remained for a number of years, and later acquired large interests in the British-American Gold Mines and in the Champion Reef (West Tree), of which he was managing director at the time of his death.

Umfreville Percy Swinburne died on November 7 at the age of 62. Educated at Merchiston Castle School, Edinburgh, and the Royal School of Mines, he was for some years manager of the Tati Concessions in Rhodesia. Later he became successively Inspector of Mines in the Transvaal, Pretoria, Natal, and Cape districts and finally Chief Inspector of Mines in the Union. He was a member of the Institution of Mining and Metallurgy and a Fellow of the Geological Society of London.

TRADE PARAGRAPHS

Aktiebolaget Elektrisk Malmletning (the Electrical Prospecting Co.) announce that their address is now Wahrendorffsgatan 6, Stockholm.

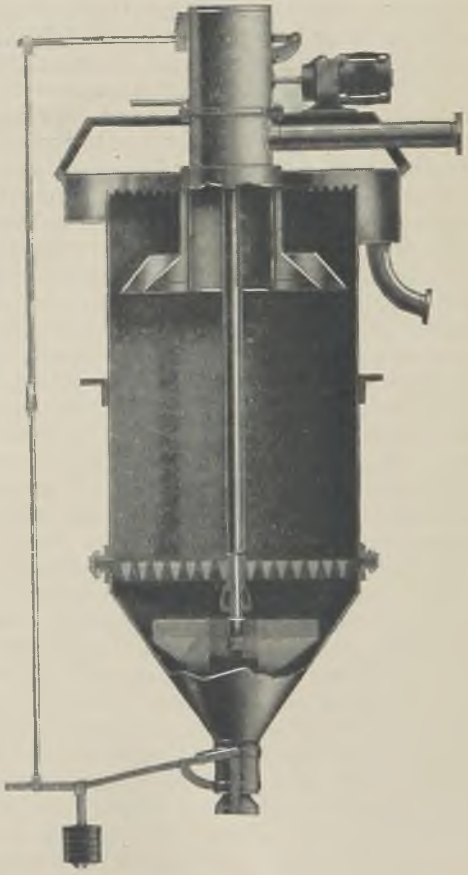
Werf Conrad N.V. of Haarlem, Holland, have appointed Curchin and Watson, of Bevis Marks House, Bevis Marks, E.C. 3, as their London agents.

Crossley Brothers, Ltd., of Openshaw, Manchester, draw attention to a report regarding two of their vertical Diesel engines after the completion of 2,350 hours' running with various loads from light to full, the average being about 48½ k.w. and 72 b.h.p.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, publish catalogues devoted to their rotary screens and to McCully crushers, which latter are produced as a result of the alliance which has recently been effected between this firm and the **Allis-Chalmers Manufacturing Co.** The McCully crusher is of the gyratory type.

Consett Iron Co., Ltd., of Consett, Co. Durham, issue a booklet describing their Bearco copper-bearing steel, which can be supplied in the form of plates, sections, bars, etc., at little more cost than ordinary commercial steels. This steel can be rolled and fabricated even when it contains up to 1% of copper, but a lower percentage is generally recommended and it has been shown to have considerable corrosion-resisting properties.

Kinetic Elutriators, Ltd., of 11, Southampton Row, London, W.C.1, draw attention to their de-slimer, which is the latest addition to the Andrews products. The de-slimer is in effect an adaptation of the sand de-watering tank, which forms an essential part of the Andrews hydraulic classifier, as reference to the Magazine for November, 1927, and February, 1928, will show. It is illustrated in the accompanying photograph. Material suspended in water is fed in at the top either by gravity or with aid of a pump. The fines or slime content, with the bulk of the water, overflow at the top. The coarse part settles at the bottom, where it is de-watered and discharged continuously.

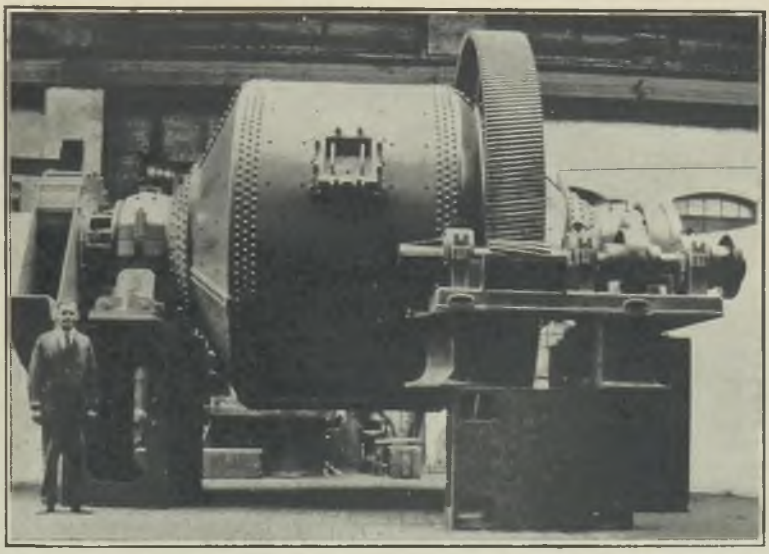


This discharge is automatically controlled so as to keep pace with the input. A very clean separation of sand from slime is effected and the discharge control mechanism consumes only ¼ h.p. It is useful for preliminary classification, washing, and de-watering.

Westinghouse Electric International Co., of 2, Norfolk Street, Strand, London, W.C. 2 (Head office: New York), have issued a number of leaflets devoted to the following:—Westinghouse-Nuttall flexible couplings and speed reducers, type MC mill motors, explosion tested control and type RH motors, "Simplex" synchronous motors suitable for driving crushing rolls and tube-mills and suchlike, fan-cooled type CS squirrel cage motors, "Flexarc" A-C welders, type CU single-phase motors suitable for application on pumps, compressors, fans, etc., and the Westinghouse link-grate stoker, the operation of which is fully described in a well-illustrated booklet.

W. H. Dorman and Co., Ltd., of Stafford, have issued a fully-illustrated catalogue of their well-known petrol and Diesel engines, which gives particulars of many light duties for which these are suitable, such as driving air-compressors, small locomotives, tractors, and suchlike. Petrol-paraffin engines in four and six cylinder sizes are already well-known, having long been incorporated in the machines mentioned and also widely in motor lorries. The Diesel engine is, however, a comparatively recent addition to their products. This is made in a range of sizes giving from 28 to 80 b.h.p. and is a 4-cycle, cold-starting, airless-injection compression-ignition engine, the cylinders being cast in pairs according to size.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C.1, have recently despatched to the Mufulira Copper Co., Northern Rhodesia, two of the largest Hardinge mills ever built. These were constructed in this country, their size being 10 ft. diameter by 72 in. cylinder, and a photograph of one of them is reproduced here. They are for a duty of 750 short tons per day of 24 hours, grinding quartzitic copper ore. They also report having received the following recent orders: For England: One No. 3 Raymond pulverizer for starch, one 3 ft. by 5 ft., type 39, 1-surface Hum-mer electric screen for wet coal, one 3 ft. by 5 ft., type 39, 2-surface Hum-mer electric screen for the same duty, one Andrews de-slimer for sand and gravel, and one No. 00 Raymond pulverizer for poisonous material. For Malaya: One 6 ft. by 22 in. Hardinge ball mill for run-of-mine mudshale and granite tin ore. For Australia: One No. 00 Raymond pulverizer for hydrated lime. For Rangoon: One No. 3 "Impax" pulverizer for bone meal. For Rhodesia: one 8 ft. by 60 in. Hardinge ball-mill for lead-zinc ore.



THE LARGEST HARDINGE MILL EVER BUILT.

PUBLIC WORKS, ROADS, AND TRANSPORT EXHIBITION

As announced in the MAGAZINE last month the Public Works, Roads, and Transport Exhibition, which is held every two years, took place at the Agricultural Hall, London, N., from November 16 to 21, where there were a number of exhibits of interest to mining men, concerning which brief notes are appended of the more important:

R. A. Lister and Co., Ltd., of Dursley, Glos., were displaying small petrol and Diesel engines and light rail trucks.

Thos. Firth and John Brown, Ltd., of Sheffield, were making a specialty of stainless and "Staybrite" goods and fittings.

H. R. Marsden, Ltd., of Leeds, were showing their Blake Marsden jaw crushers, which are well known to readers of the MAGAZINE.

Priestman Brothers, Ltd., of Hull, were making a special feature of their ½ cubic yard Diesel universal excavator suitable for light contract duty.

Brown Bayley's Steel Works, Ltd., of Leeds Road, Sheffield, were displaying a variety of their products, including stainless steel and rock-drill steel.

Parker, Winder, and Achurch, Ltd., of Broad Street, Birmingham, were displaying a full range of screens, including rotary and steel grids and bar screens.

W. H. Dorman and Co., Ltd., of Foregate Street, Stafford, were showing their well-known Dorman engines, which are referred to elsewhere in this issue.

Robert Hudson, Ltd., of 38a, Bond Street, Leeds, were showing their double side-tipping rail wagon of various shapes and sizes, also light railway trackwork and accessories.

Consolidated Pneumatic Tool Co., Ltd., of 170, Piccadilly, London, W. 1, exhibited a wide range of pneumatic tools, together with accessories such as air-compressors, etc.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, were showing a variety of their products, which included tunnel and shaft segment plates and various road makers' tools.

J. and F. Pool, Ltd., of Hayle, Cornwall, were showing various types of revolving screens and sand and gravel washing plant, together with various classes of perforated plates and woven wire material.

Tangyes, Ltd., of Birmingham, had an exhibit which included a 24 b.h.p. heavy fuel oil engine, other smaller engines, a six-stage horizontal turbine pump, and examples of smaller pumps and lifting tackle.

F. C. Hibberd and Co., Ltd., of 16, Northumberland Avenue, London, W.C. 2, were showing their customary range of " Planet " petrol and Diesel engines in horse powers ranging from 1 to 10 and 1 to 25.

Cooke, Troughton, and Simms, Ltd., of Broadway Court, London, S.W.1, were displaying surveying instruments and drawing office equipment, including theodolites, levels, and levelling and stadia staves.

Goodwin, Barsby, and Co., Ltd., of Leicester, were showing examples of their stonebreakers and screening machines suitable for light contract work, including primary breakers, granulators, fine crushing rolls, and rotary screens.

Robert Broadbent and Son, Ltd., of Stalybridge, were exhibiting Blake type stonebreakers, which are made in all sizes from 4 by 3 in. to 36 by 24 in., together with crushing rolls, which are made in sizes from 18 by 10 in. to 36 by 36 in.

William Jones, Ltd., of 154/5, Upper Thames Street, London, E.C. 4, were showing a variety of light railway equipment, including Montania petrol and Diesel locomotives, side-tip wagons, dump cars, portable railway track, rails, sleepers, fastenings, etc.

Patent Lightning Crusher Co., Ltd., of 14a, Rosebery Avenue, London, E.C. 1, were exhibiting their crusher and granulator, which is a swinging hammer type of machine, the speed of rotation of the hammers determining the grade of the product.

Huntington, Heberlein, and Co., Ltd., of 47/51, King William Street, London, E.C. 4, were showing the " H.H." Overstrom vibrating screen and also the " H.H." jigging screen, particulars of which have already appeared in the MAGAZINE.

B. H. Neal and Co., Ltd., of Ealing, London, W. 5, were exhibiting a new design of contractors' petrol mobile crane, which is of 2 to 3 tons capacity and is mounted on a self-propelled steel undercarriage and may be supplied with rail wheels or caterpillars.

Lead Wool Co., Ltd., of Snodland, Kent, as well as their lead wool jointing material and various types of joints that are made with it, were showing portable air-compressor plants fitted with both Lister and Dorman engines and a range of pneumatic tools.

Reavell and Co., Ltd., of Ranelagh Works, Ipswich, were showing their range of petrol and Diesel-engine driven air-compressors, including a 2-cylinder vertical compressor having a displacement of 148 cu. ft. per minute at 1,000 r.p.m. and a working pressure of 100 lb. per sq. in.

Air Pumps, Ltd., of Emerson Street, Southwark Bridge, London, S.E. 1, were exhibiting portable air-compressors equipped with Dorman petrol engines and one equipped with the new Dorman Diesel engine, also stationary compressors and a variety of pneumatic tools and rock-drills.

Fraser and Chalmers Engineering Works, of Erith, Kent, were showing the Robins-Gyrex and Vibrex mechanically-operated screens and their own Sherwen screen electro-magnetically operated, both of which have been described in these columns, respectively in April, 1930, and April, 1931.

Nordberg Manufacturing Co., of Bush House, London, W.C. 2, were exhibiting the Symons patent cone crusher, which is already well known by mining men and which was ably demonstrated by means of a working model which could be disassembled to disclose the various working and wearing parts. The crusher was fully described in the MAGAZINE for July, 1929.

Wallwin Co., of Saltisford Ironworks, Warwick, were showing their non-chokeable pumps, such as were described in the MAGAZINE for June, 1930. These pumps have the special characteristic that their working parts are lined with a special type of hard rubber, manufactured by the **British Goodrich Rubber Co., Ltd.**

Ross Patents, Ltd., of Abbey House, 2, Victoria Street, London, S.W. 1, were demonstrating by means of models their feeders and vibrating screens and other specialties, all of which have been described from time to time in these columns, especially in the issues for February, 1926, December, 1927, and September last.

Dorr Co., Ltd., of Abford House, Wilton Road, London, S.W.1, were demonstrating by means of a working model the " Dorrco " mechanically-cleaned bar screen, the clarifier, which is a sedimentation tank equipped with means for continuously removing sludge, and other specialties of more particular interest to the contracting engineer.

E. F. Sargeant, of Skelton, York, was exhibiting working models of the Sauerman tower scraper, cable excavator working in conjunction with a gravel pump, and drag scraper plant, which have been developed by **Sauerman Bros., Inc.,** of Chicago, and of which the manufacturing rights in this country have been acquired by the exhibitor.

Ransomes and Rapier, Ltd., of Ipswich, had as a principal exhibit their type 420 ½ cubic yard universal excavator, which was shown equipped as a skimmer scoop. Diesel engine driven through clutch and gear-box, this shovel is readily adaptable for use as a dragline, a grab, a crane, or a pile driver.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, were demonstrating the Hum-mer screen, which is too well-known to need any further description here.

The model exhibited was that having two vibrators and a single screen. Also shown on this stand was the well-known Ro-Tap testing sieve shaker and the Andrews rapid laboratory elutriator, which have been fully described in these columns as valuable testing accessories.

Robey and Co., Ltd., of Lincoln, were showing their straight-line Diesel air-compressor already described in these columns. This type, which was first shown at this exhibition two years ago, has met with such success that it has been produced in a number of sizes, ranging from 100 to 240 cu. ft. of air per minute in single stage units and up to 750 cu. ft. in double stage units. Also shown was a 16 by 10 in. unbreakable stone crusher.

Sika-Francois, Ltd., of 39, Victoria Street, London, S.W.1, which is a subsidiary of the **Francois Cementation Co., Ltd.,** were demonstrating the application of a rendering to a concrete wall face, over which water is passing in fair volume while the rendering is applied, and also the sealing of a hole in a concrete wall through which water is flowing in considerable volume. Various examples of waterproofing compounds were also exhibited.

Broom and Wade, Ltd., of High Wycombe, were showing a number of their portable and stationary air-compressors on one stand and on a separate stand were demonstrating petrol and Diesel engine driven plants. Their Diesel engine compressors are fitted with " Lister " engines and are made in two sizes for delivering respectively 100 and 170 cu. ft. of air per minute at a working pressure of 100 lb. per sq. in. Petrol engine compressors of the same capacity were also shown.

Atlas Diesel Co., Ltd., of New Oxford House, Hart Street, London, W.C. 1, were showing compressed-air machines and tools, including rock-drills, among which was the lightweight hand-hammer drill, type B.25, for high speed work in hard rock. A new type of compressor has an enclosed 4-cylinder 4-cycle petrol engine manufactured by the **Atlantic Engine Co., Ltd.,** of Wishaw, which is direct coupled by a detachable flexible coupling to an " Atlas " 2-cylinder single-stage compressor.

Ruston and Hornsby Diesel Locomotive.

Ruston and Hornsby, Ltd., in conjunction with **Ruston-Bucyrus, Ltd.,** both of Lincoln, were joint occupants of a large stand, the main item on which was the new No. 4 universal ½ cubic yard excavator, Diesel engine driven, the engine being the Ruston 2 VQ type. Examples of fuel-oil and petrol-paraffin engines included a portable crude-oil engine which consists of a standard cold-starting horizontal engine of 25 b.h.p. mounted on a steel chassis, suitable for belt connecting to light crushing units and similar plants. Of outstanding interest, however, in this exhibit was a new Diesel locomotive, which was displayed for the first time. This is driven through a triple-disc clutch and three-speed gear-box and is suitable for haulage work in open-cast mining operations, a unit being illustrated in the accompanying photograph. The engine is a 10 b.h.p. and has a drawbar pull of approximately 12,000 lb. at 2½ m.p.h., 700 lb. at 4 m.p.h., or 450 lb. at 6 m.p.h. in either direction.

Petters, Ltd., of Yeovil, were showing a new engine known as the Petter twin four, which was exhibited for the first time. It is a four-stroke, horizontally opposed, twin-cylinder magneto ignition petrol engine of 550 c.c., with a bore of 65 m/m, and stroke of 85 m/m, developing 4 h.p. continuously. The engine has a speed of 1,500 r.p.m. The driving pulley fitted on a half speed shaft has a speed of 750 r.p.m. Dynamos and other high speed machines can be coupled direct to the engine crankshaft.

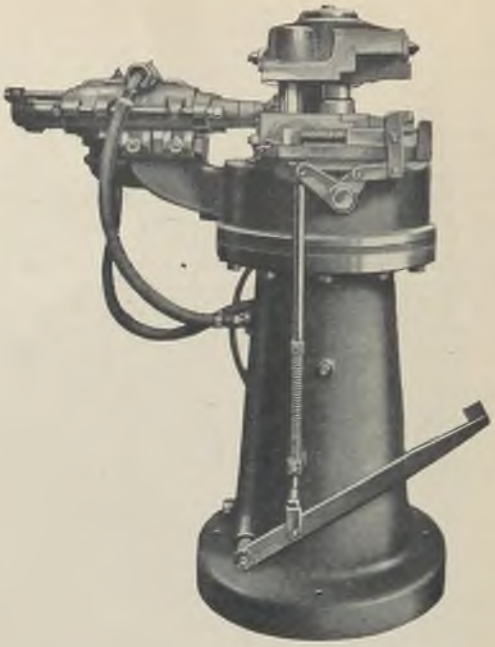
Ingersoll-Rand, Co., Ltd., of 165, Queen Victoria Street, London, E.C. 4, among quarrying and tunnelling equipment displayed a wide range of rock-drills, hand held, column and tripod mounted, including " Jackhamers," drifters and sinkers; also a No. 40 Leyner drill-steel sharpener and a 6-F oil furnace for heating these steels. A new hoist was exhibited for the first time. This is a double drum electric machine, designed for hoisting as well as for scraping work, which is available in a number of sizes from 7 to 35 h.p.

Marshall, Sons, and Co., Ltd., of Gainsborough, makers of Diesel oil engines, drying plant for sand and gravel, etc., and stone breaking, screening, and suchlike equipment, had on their stand plant of particular interest to mining men, including an industrial tractor of which the power unit is a two-stroke single-cylinder horizontal engine, developing 15 to 30 b.h.p., having three forward speeds of 3, 5¼, and 8¾ m.p.h. and a reverse speed of 3¾ m.p.h., which will haul 4½ tons on a 15% gradient or 15 tons on a 3% gradient.

Blackstone and Co., Ltd., of Stamford, were showing a number of their well-known oil engines. Among the high speed class was a 6-cylinder 55 to 60 b.h.p., a 4-cylinder 36 to 40 b.h.p., and a 2-cylinder 18 to 20 b.h.p., fitted to a portable compressor set. As an example of slow speed engines there was the 55 b.h.p. oil engine, such as are built in single and multi-cylinder units and power ranging from 6 to 1,200 b.h.p. Also shown was their unchokeable pump suitable for work in unscreened sludges, sand, etc.

Hadfields, Ltd., of Sheffield, had an exhibit consisting mainly of stone-breaking plant suitable for preparing material for road-making purposes and three units were shown, a portable breaker and screen plant, a granulator, and a " Hecla " 24 in. disc crusher. These machines are already too well-known to need further description here. All Hadfield crushers are fitted with renewable parts in their well-known " Era " manganese steel. Other exhibits included hollow and solid mining drill-steel and various parts in " Era " H.R. heat-resisting steel and in C.R. non-corroding steel.

Climax Rock Drill and Engineering Works, Ltd., of Carn Brea, Redruth, were showing their customary range of rock-drilling equipment. Of special interest on this stand was the Climax " S " type drill-sharpener, with dies and dollies suitable for handling hand-hammer drill-steels, of which the following are the principal particulars :—It is designed with the operating cylinder on the underside of the bottom die block, with the dollying hammer and the pin punch conveniently mounted at the back. It has spaces to take three sets of forging tools in the front and has a pin puller mounted on the side. The pin punch is designed on the same principle as on the larger sharpeners made by the company and will knock the pin into the steel as well as knock it out. Its capabilities



CLIMAX " S " TYPE DRILL SHARPENER.

are as follows :—Maximum size of bit 2¾ in. and of steel handle 1 in., hexagon or square shanks on round steel and hexagon shanks on hexagon steel. It makes any standard shape of bit—cross, rose, double or single chisel, and " Z."

Holman Bros., Ltd., of Camborne, occupied two separate stands, on which were exhibited examples of their well-known rock-drills, air-compressors, and hoisting equipment. Of particular interest is a new type of drill-steel sharpener known as the " Newgrip," which has been expressly designed for making and sharpening bits more quickly, more cheaply, and more satisfactorily

UPSETTING IN THE " NEWGRIP."

SWAGING IN THE "NEWGRIP."

than can be done on the smith's anvil. The principal feature of this sharpener is that one valveless-type air hammer with a 3½ in. diameter piston serves for both upsetting and swaging. For the former operation it occupies a horizontal position and acts on the dolly, whilst for swaging it is swung into a vertical position and delivers its blows on the top forming die. The forging is therefore performed by the only really correct and natural method—i.e., the direction of the blows is downwards—which calls for far less manual effort on the part of the operator than when the blows of a hammer are struck from below or from one side. Clamping of the steel for upsetting, being done by direct air pressure, is positive and no links, levers, toggles, or other mechanical devices are employed. The amount of air used in clamping, however, makes no appreciable difference to the air consumption, as, when the hammer is swung from the vertical to the horizontal position, the gripping dies close on the steel and the gripping piston travels only $\frac{3}{8}$ in.

METAL MARKETS

COPPER.—The month of November saw a tug-of-war on the London copper market between adverse sentiment, which tended to depress prices, and the weak sterling exchange which tended to harden them. On balance, Standard quotations were but little changed on the month, although the dollar exchange eased further to 3·47 and the American export quotation for electrolytic fell from 7·25 cents to 6·75 cents per lb., f.a.s. At prolonged negotiations in New York the American and African producers were unable to agree as regards further output restriction, and although these negotiations may be resumed, the position of Copper Exporters Inc. seems shaky and a prominent producer has withdrawn from it. The American producers have suspended the publication of their monthly statistics, but it is assumed that stocks there are still increasing. Industrial demand has remained subdued.

Average price of Standard Cash Copper: November, 1931, £35 18s. 1d.; October, 1931, £35 0s. 1d.; November, 1930, £46 3s. 8d.; October, 1930, £43 1s. 5d.

TIN.—The tendency of sterling prices during November was firm, but it is significant that the gold price in America fell from 22·62½ cents to 21·40 cents per lb. Industrial demand has been quiet, but producers are to curtail output by a further 15% from January 1 next, and in some quarters it is thought that 1932 will see at last a definite reduction in the "visible supplies." The latter last month recorded hardly any change at about 50,000 tons, but the "carry-over" in the Straits registered a further expansion of about 700 tons.

Average price of Cash Standard Tin: November, 1931, £132 18s. 10d.; October, 1931, £127 0s. 9d.; November, 1930, £113 11s. 10d.; October, 1930, £117 11s. 1d.

LEAD.—The tendency during November was quite firm, despite setbacks at times. This seems to have been mainly due to exchange considerations, for industrial demand has been quiet. In America the situation has been rather discouraging, as the latest statistics have shown an increase both in production and stocks. The American quotation receded from 4 cents to 3·85 cents per lb.

Average mean price of soft foreign lead: November, 1931, £14 10s. 8d.; October, 1931, £13 4s. 11d.; November, 1930, £15 18s. 7d.; October, 1930, £15 14s. 2d.

SPELTER.—Prices were rather firmer during November, as although industrial interest remained quiet, sentiment was encouraged by the knowledge that the Zinc Cartel had decided to cut output by a further 5% to 50% as from December 1, and by the news that its stocks during October were reduced further to 191,000 tons. That the market has not been strong measured by gold standards, however, is shown by the drop in the American price from 3·25 cents to 3·12½ cents which occurred during the month.

Average mean price of spelter: November, 1931, £14 0s. 10d.; October, 1931, £12 19s. 5d.; November, 1930, £14 19s. 5d.; October, 1930, £14 13s. 9d.

IRON AND STEEL.—The British pig-iron market enjoyed fairly good business during November, stocks being reduced, thanks to the improved demand which has developed. Prices are steady, the minima for Cleveland foundry and forge grades being unaltered with No. 3 quoted at 58s. 6d. Hematite has been a moderately good market, though there are still substantial stocks to be worked off; East Coast Mixed Numbers are quoted at 65s. A number of blast furnaces have been relit in the U.K. As regards finished steel there has so far been no very marked improvement, but future prospects are regarded hopefully. So far the Government has not disclosed its intentions as regards the suggested import duties on foreign iron and steel.

IRON ORE.—A few cargoes continue to be bought by British ironmasters, the pig-iron position in this country showing a slight improvement. An interesting feature is the sale of Russian iron ore here recently. Prices are somewhat nominal on the basis of about 16s. 6d. per ton c.i.f. for best Bilbao rubio.

ANTIMONY.—At the close of the month English regulus was quoted at from about £40 to £42 10s. per ton. Chinese metal was in restricted demand with spot material quoted at £28 5s. ex warehouse and £26 5s. per ton c.i.f. for shipment from China.

LONDON DAILY METAL PRICES.

Copper, Tin, Zinc, and Lead per Long Ton; Silver per Standard Ounce; Gold per Fine Ounce.

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electro-lytic.	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Nov.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	36 18 9	37 8 9	42 0 0	—	132 2 6	134 1 3	13 16 3	14 17 6	16 10 0	20¾	20⅝	109 0
12	37 4 4½	37 16 10½	42 5 0	—	132 16 3	134 16 3	13 15 0	14 12 6	16 5 0	21 7/16	21¼	109 3
13	37 8 9	38 1 3	43 5 0	39 5 0	133 2 6	135 3 9	14 1 3	14 18 9	16 5 0	21⅛	20 15/16	109 0
16	38 6 10½	38 18 1½	44 0 0	—	134 3 9	136 5 0	14 0 0	15 1 3	16 10 0	18	17 15/16	109 2
17	37 13 9	38 6 3	44 0 0	39 5 0	134 7 6	136 7 6	14 3 9	14 16 3	16 5 0	18⅛	18¾	108 6
18	35 13 9	36 3 9	42 0 0	—	131 18 9	133 18 9	14 0 0	14 12 6	16 5 0	18 1/16	17 15/16	108 9
19	33 4 4½	33 16 10½	40 10 0	—	131 3 0	133 6 3	13 15 0	14 8 9	16 0 0	18 1/16	18 1/16	109 1
20	33 16 3	34 6 3	40 0 0	35 5 0	133 6 3	135 8 9	14 0 0	14 11 3	16 0 0	18 1/16	18 1/16	109 7
23	33 16 10½	34 6 10½	40 0 0	—	135 16 3	138 2 6	14 3 9	14 18 9	16 5 0	18 1/16	18⅛	111 9
24	33 13 9	34 3 9	40 0 0	35 0 0	135 16 3	138 6 3	14 2 6	14 18 9	16 5 0	18 1/16	18¼	113 5
25	33 15 7½	34 6 10½	40 0 0	—	137 3 9	139 13 9	14 0 0	14 15 0	16 5 0	18 1/16	18⅝	111 10
26	32 6 3	32 18 9	39 0 0	—	135 6 3	137 16 3	13 13 9	14 11 3	16 0 0	18 1/16	18⅜	114 2
27	34 11 3	35 1 3	42 10 0	35 15 0	137 2 6	139 13 9	13 17 6	14 15 0	16 5 0	19⅛	19 1/16	115 0
30	36 3 9	36 16 3	42 10 0	—	136 6 3	139 1 3	14 0 0	15 0 0	16 5 0	18 13/16	19	117 11
Dec.												
1	37 18 9	38 11 3	45 0 0	39 5 0	138 8 9	141 2 6	14 10 0	15 8 9	16 15 0	19⅛	19⅛	125 0
2	37 8 9	38 1 3	45 0 0	—	137 6 3	140 2 6	14 7 6	15 1 3	16 10 0	19 1/16	19⅛	126 7
3	36 13 9	37 6 3	43 10 0	—	136 11 3	139 8 9	14 8 9	15 1 3	16 10 0	19⅛	19 1/16	122 3
4	36 14 4½	37 6 10½	43 0 0	38 0 0	136 8 9	139 6 3	14 7 6	15 1 3	16 10 0	19 1/16	19⅛	122 0
7	38 1 3	38 13 9	45 0 0	—	138 3 9	141 2 6	14 10 0	15 6 3	16 15 0	20⅛	20 1/16	126 2
8	38 11 3	39 3 1½	45 0 0	39 15 0	138 6 3	141 3 9	14 10 0	15 10 0	17 0 0	20 1/16	20⅛	126 10
9	38 1 3	38 13 9	45 0 0	—	137 6 3	140 3 9	14 3 9	15 2 6	16 15 0	19⅞	19 15/16	126 6
10	37 11 3	38 3 1½	45 0 0	—	136 16 3	139 16 3	14 1 3	15 0 0	16 10 0	2 1/16	20⅝	125 3

ARSENIC.—There is hardly any Cornish offering and the price is nominal at around £23 per ton f.o.r. mines. Mexican high-grade remains nominal owing to exchange difficulties.

BISMUTH.—The official price is unaltered at 6s. 4d. per lb. for 5 cwt. lots and over, demand remaining fair.

CADMIUM.—A quiet but steady business is passing, prices now standing at 2s. 5d. to 2s. 6d. per lb.

COBALT METAL.—The official price is unchanged at 3.75 dollars per kilo, the magnet steel trade having been a fairly good buyer recently.

COBALT OXIDES.—Heavy imports of cobalt oxides in anticipation of a tariff has been a feature of the market recently, but prices are steady at 4s. (gold) for black and 4s. 9d. (gold) for grey.

CHROMIUM METAL.—Prices stand at about 3s. per lb. delivered.

TANTALUM.—Some fairly good business has been done recently, prices being in the neighbourhood of £25 to £30 per lb.

PLATINUM.—Prices continue to advance to counteract the depreciation in sterling, current quotations for refined metal being £11 7s. 6d. to £11 13s. 6d. per oz. Demand, however, is poor.

PALLADIUM.—Quotations stand at about £4 15s. to £5 per oz., very little business having been done recently.

IRIDIUM.—There is no particular interest on the part of buyers, but sterling quotations are higher at £27 per oz.

OSMIUM.—About £16 to £16 10s. per oz. is named.

TELLURIUM.—Quotations for this metal are quite nominal in the absence of business.

SELENIUM.—A quite demand is maintained, but prices are nominal owing to exchange considerations.

MANGANESE ORE.—Business has fallen away to practically nothing again, but prices are unchanged at about 10¼d. to 10½d. per unit c.i.f. for best Indian, with washed Caucasian ore about 9d. to 9½d. c.i.f.

ALUMINIUM.—A fairly good enquiry has developed from users in this country, prices here at £95 for ingots and bars being below the international value of the metal, which remains at £85 gold.

SULPHATE OF COPPER.—Current quotations for English material are about £18 to £18 10s. per ton, less 5 %.

NICKEL.—Only a moderate business is passing, but prices continue to advance as sterling declines, the present value being £250 to £255 per ton.

CHROME ORE.—A fair enquiry continues, but quotations can only be considered nominal, leading sellers quoting 80s. per ton c.i.f. for good 48% Rhodesian ore and 95s. to 100s. c.i.f. for 55 to 57% New Caledonian, plus extras occasioned by exchange considerations.

QUICKSILVER.—This has been an irregular market, as although the official quotation of the Italo-Spanish combine is nominally unchanged at 80 dollars per flask f.o.b., the spot price in London is nominally £20 per flask net.

TUNGSTEN ORE.—Hardly any business has been placed recently, and quotations are difficult to ascertain. Forward shipment from China is quoted at around 15s. to 15s. 6d. per unit c.i.f. with spot material in the neighbourhood of 14s. 6d.

MOLYBDENUM ORE.—Somewhere about 37s. to 38s. per unit c.i.f. is named for odd lots, but leading shippers are still holding for higher figures.

GRAPHITE.—Business is slow, with prices fairly steady in the region of £16 to £18 per ton c.i.f. for good 85 to 90% raw Madagascar flake, and £17 to £19 for 90% Ceylon lumps of average hardness.

SILVER.—Widespread interest has been centred on the silver market during the past month and prices have moved over wide limits. At one time prices rose very sharply, mainly on huge speculative purchases, largely by America, but subsequently an easier tone prevailed, and although many suggestions continue to be put forward for the rehabilitation of this metal, nothing concrete has been done, and its re-monetization still lacks support in well-informed quarters, as may be gathered from the fact that Mr. Franklin, senior partner of Samuel Montagu and Co., recently dismissed it as impracticable when speaking to a luncheon of the American Chamber of Commerce in London. On November 2 spot bars stood at 18½d. rising to 21 5/16d. on November 10, and closing at 18 13/16d. on November 30.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
November, 1930	844,038	40,715	884,753
December	867,202	41,290	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937
March	869,331	41,667	910,998
April	840,259	42,078	882,337
May	867,949	42,330	910,279
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510

TRANSVAAL GOLD OUTPUTS.

	October.		November.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	104,000	£156,075	97,000	£147,381
City Deep	81,000	20,696	69,000	18,653
Cons. Main Reef	67,000	22,828	66,000	22,654
Crown Mines	271,000	84,087	261,000	81,586
D'rb'n Roodepoort Deep	49,000	15,628	48,200	15,267
East Geduld	45,000	£12,608	45,000	£13,516
East Rand P.M.	160,500	42,746	156,000	40,920
Geduld	86,500	27,674	83,600	26,801
Geldenhuis Deep	74,500	17,524	73,000	16,751
Glynn's Lydenburg	6,400	2,665	6,400	2,822
Government G.M. Areas	210,000	£415,823	194,000	£388,372
Kleinfontein	52,100	9,925	50,900	9,888
Langlaagte Estate	84,000	£114,804	75,000	£106,626
Luipaard's Vlei	32,000	£7,998	30,700	£7,755
Meyer and Charlton	18,300	£19,569	9,920	£12,612
Modderfontein New	170,000	67,738	161,000	64,016
Modderfontein B	76,000	22,938	74,500	22,164
Modderfontein Deep	46,000	22,788	44,000	21,797
Modderfontein East	75,000	21,731	72,000	21,163
New State Areas	87,000	£183,277	73,000	£160,947
Nourse	70,000	20,985	69,000	20,674
Randfontein	250,000	£286,180	240,000	£272,387
Robinson Deep	100,000	28,625	96,000	27,744
Rose Deep	64,000	13,009	62,000	12,728
Simmer and Jack	77,300	22,695	75,200	20,999
Springs	76,000	£152,478	70,000	£143,942
Sub Nigel	36,500	30,567	36,000	130,518
Transvaal G.M. Estates	16,600	5,112	16,200	5,292
Van Ryn	46,000	£44,521	46,000	£43,742
Van Ryn Deep	67,000	£97,420	62,000	£92,864
West Rand Consolidated	94,500	£106,502	91,500	£103,506
West Springs	76,500	£78,078	73,100	£73,636
Witw'tersr'nd (Knights)	64,000	£54,706	61,000	£52,428
Witwatersrand Deep	37,100	11,594	36,500	11,632

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

Compiled from official statistics published by the Transvaal Chamber of Mines.

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
August, 1930	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	2,481,600	28 6	20 1	8 5	1,045,980
March	2,718,400	28 2	19 9	8 5	1,151,017
April	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	—	—	—	—	1,210,743

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
November 30, 1930	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781
April 30	206,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581

PRODUCTION OF GOLD IN RHODESIA.

	1928	1929	1930	1931
	oz.	oz.	oz.	oz.
January	51,356	46,231	46,121	45,677
February	46,286	44,551	43,385	42,818
March	48,017	47,388	45,511	42,278
April	48,549	48,210	45,806	43,776
May	47,323	48,189	47,645	43,731
June	51,762	48,406	45,208	44,118
July	48,960	46,369	45,810	44,765
August	50,611	46,473	46,152	43,292
September	47,716	45,025	46,151	42,846
October	43,056	46,923	45,006	44,260
November	47,705	46,219	44,351	—
December	44,772	46,829	46,485	—

RHODESIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	23,600	9,794	24,800	9,905
Globe and Phœnix	6,058	5,441	6,062	6,401
Lonely Reef	7,500	3,294	7,500	3,054
Luiri Gold	1,237	999	—	—
Rezende	6,400	2,633	6,400	2,629
Sherwood Star	4,600	£8,930	4,600	£7,913
Wanderer Consolidated	14,800	3,643	15,300	3,232

WEST AFRICAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	4,428	£8,393	5,143	£9,716
Ashanti Goldfields	12,787	14,776	12,785	£14,613
Taquah and Abosso	9,837	£14,705	9,870	£14,162

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
November, 1930	33,708	2,174	436
December	42,097	3,105	260
January, 1931	27,306	—	405
February	38,370	4,458*	458
March	34,946	4,482	898
April	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	3,641	1,220
August	52,501	—	610
September	38,173	—	638
October	52,741	—	—
November	53,869	—	—

* Jan. and Feb.

AUSTRALASIAN GOLD OUTPUTS.

	October.		November.	
	Tons	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,266	8,267	4,891	5,660
Blackwater (N.Z.)	4,020	8,011	3,630	7,716
Boulder Persev'ce (W.A.)	7,232	19,946	7,246	17,757
Grt. Boulder Pro. (W.A.)	10,624	29,679	9,751	26,908
Lake View & Star (W.A.)	16,739	20,382	—	—
Sons of Gwalia (W.A.)	13,094	14,206	12,690	13,876
South Kalgurli (W.A.)	9,026	16,537	9,280	15,328
Waihi (N.Z.)	17,900‡	{ 5,865* 41,910†	16,831§	{ 5,590* 37,799†

* Oz. gold. † Oz. silver. ‡ To October 17. § To Nov. 14.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	October.		November.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,600	2,623	3,450	2,154
Champion Reef	8,450	5,405	8,200	5,400
Mysore	15,503	9,694	16,683	8,272
Nundydroog	12,078	7,778	12,045	7,213
Ooregum	12,497	7,080	12,618	5,525

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	October.		November.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,710	15,730	10,070	14,571
Frontino Gold (C'lbia)	3,750	15,593	3,600	16,379
Fresnillo	82,653	4,099*d*†	—	—
New Goldfields of Venezuela	6,974	2,300*	6,848	2,215*
Oriental Cons. (Korea)	16,868	91,044*d*	16,746	91,736*d*
Remance	3,100	4,285	—	—
St. John del Rey (Brazil)	—	39,500	—	33,700
Santa Gertrudis (Mexico)	29,762	47,342*d*	26,455	44,153*d*
Viborita	—	1,640	—	—
West Mexican Mines	1,500	31,000*d*	—	—

d Dollars. * Oz. gold. † Loss

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 72% of Concentrate shipped to Smelters. Long Tons.

January, 1931	5,450	July, 1931	4,757
February	5,470	August	5,375
March	4,461	September	2,449
April	4,510	October	3,282
May	5,089	November	2,488
June	4,813	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Sept.	October.	November.
Ayer Hitam	101½	41½	—
Batu Caves	27	18	—
Changkat	70	25	—
Gopeng	32	42	23
Hongkong Tin	131½	—	—
Idris Hydraulic	27½	18½	1½
Ipoh	24	122½	51¾
Kampar Malaya	16	29	—
Kampong Lanjut	45	56	48
Kamunting	158½	155½	128
Kent (F.M.S.)	34	14½	—
Kinta	13½	16	13
Kinta Kellas	—	23½	17½
Kramat Tin	—	30	75
Kuala Kampar	29	40	40
Kundang	7	12	—
Lahat	16	10½	10½
Lower Perak	—	88	92
Malaya Consolidated	—	—	—
Malayan Tin	85	85	86½
Malim Nawar	22	28	26
Pahang	123	125	125
Penawat	65½	—	—
Pengkalen	55½	34	—
Petaling	69	45	106
Rahman	40	40½	40½
Rambutan	12	4	—
Rantau	28	34	3½
Rawang	40	40	45
Rawang Concessions	30	45	29
Renong	38	38½	31½
Selayang	15½	15½	—
Southern Malayan	84½	84½	84½
Southern Perak	30½	30½	30½
Southern Tronoh	30	12	34
Sungei Besi	32	33	33
Sungei Kinta	33½	31½	—
Sungei Way	74½	59½	20½
Taiping	20	21	13
Taujong	35½	9	—
Teja Malaya	—	—	—
Tekka	22	31	9
Tekka-Taiping	51	35	—
Temengor	9½	10	—
Temoh	—	—	—
Tronoh	60	60	57
Ulu Klang	23½	16⅝	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	October.	November.
Anglo-Nigerian	48¾†	52	48½
Associated Tin Mines	227	242	157
Baba River	4	4	4½
Batura Monguna	—	2½	3
Bisichi	43	43	30
Daffo	5½	5	—
Ex-Lands	50	51	38
Filani	—	3	—
Jantar	23	15	12
Jos	13	11¾	—
Juga Valley	9	10	8½
Kaduna Syndicate	25	23	—
Kaduna Prospectors	23	12	—
Kassa	11	12½	11½
London Tin	200	160	120
Lower Bisichi	4½	4½	—
Naraguta Extended	—	—	—
Nigerian Consolidated	11	10	10
Offin River	3½	1½	2¾
Ribon Valley	14½	10	10
Tin Fields	5¾	6½	5
United Tin Areas	18	17	14½
Yarde Kerri	4	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	October.	November.
Anglo-Burma (Burma)	41	42½	36½
Aramayo Mines (Bolivia)	190	189	161
Bangrin (Siam)	111½	110¾	—
Beralt	32½	30*	30*
Consolidated Tin Mines (Burma)	140	130	100
East Pool (Cornwall)	46½	46	46
Fabulosa (Bolivia)	54	56	—
Kagera (Uganda)	16	18	—
Kamra	34	26½	—
Malaysiam Tin	8½	8½	9
Mawchi	219*	—	209*
Patino	1,058	1,039	—
Pattani	—	84½	—
San Finx (Spain)	21½*	21¾*	—
Siamese Tin (Siam)	190½	203¾	—
Tavoy Tin (Burma)	62	75	56
Tongkah Harbour (Siam)	65	38	25
Toyo (Japan)	66	61	73
Zaaiplaats	17¾	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		October	November
Broken Hill South	Tons lead conc.	5,140	4,814
	Tons zinc conc.	5,867	5,218
Burma Corporation	Tons refined lead.	5,880	5,880
	Oz. refined silver	470,000	470,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	350	350
Messina	Tons copper	780	728
Mount Isa	Tons lead bullion	—	—
Mount Lyell	Tons concentrates	3,828	3,459
North Broken Hill	Tons lead conc.	5,390	4,830
	Tons zinc conc.	5,000	4,590
Rhodesia Broken Hill	Tons V_2O_5	30	31½
	Tons slab zinc	—	—
Roan Antelope	Tons concentrates	5,158	3,001
	Tons blister copper	506	3,182
San Francisco Mexico	Tons lead conc.	3,887	3,670
	Tons zinc conc.	3,433	—
Tetiuhe	Tons lead conc.	577	390
	Tons zinc conc.	1,750	1,117
Trepca	Tons lead conc.	3,531	3,319
	Tons zinc conc.	3,435	3,815
Zinc Corporation	Tons lead conc.	5,730	5,654
	Tons zinc conc.	4,789	4,475

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM.

		September.	October.
Iron Ore	Tons	112,843	134,788
Manganese Ore	Tons	3,563	3,815
Iron and Steel	Tons	220,285	275,695
Copper and Iron Pyrites	Tons	8,719	9,063
Copper Ore, Matte, and Prec.	Tons	1,503	2,831
Copper Metal	Tons	13,076	13,252
Tin Concentrate	Tons	4,922	4,285
Tin Metal	Tons	231	671
Lead Pig and Sheet	Tons	29,747	22,295
Zinc (Spelter)	Tons	10,699	9,466
Zinc Sheets, etc.	Tons	1,880	3,029
Aluminium	Tons	652	3,807
Mercury	Lb.	100,746	151,558
Zinc Oxide	Tons	576	1,054
White Lead	Cwt.	13,884	18,443
Red and Orange Lead	Cwt.	3,071	5,242
Barytes, ground	Cwt.	30,265	47,883
Asbestos	Tons	854	1,354
Boron Minerals	Tons	1,124	416
Borax	Cwt.	11,614	14,413
Basic Slag	Tons	4,630	9,211
Superphosphates	Tons	3,075	6,497
Phosphate of Lime	Tons	5,722	13,289
Mica	Tons	158	126
Sulphur	Tons	756	4,285
Nitrate of Soda	Cwt.	2,120	177,939
Potash Salts	Cwt.	309,633	970,130
Petroleum: Crude	Gallons	17,496,196	24,518,771
Lamp Oil	Gallons	24,733,200	22,554,601
Motor Spirit	Gallons	63,287,700	84,517,218
Lubricating Oil	Gallons	8,200,146	12,290,692
Gas Oil	Gallons	9,373,011	11,089,930
Fuel Oil	Gallons	32,769,654	42,692,763
Asphalt and Bitumen	Tons	9,167	13,862
Paraffin Wax	Cwt.	108,474	119,922
Turpentine	Cwt.	69,036	29,884

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	September.	October.	November.
Anglo-Ecuadorian	19,854	19,521	15,499
Apex Trinidad	42,970	46100	40,600
Attock	1,628	1659	1,832
British Burmah	4,285	4,443	—
British Controlled	42,761	41,636	—
Kern Mex	957	981	920
Kern River (Cal.)	2,883	3,138	2,922
Kern Romana	1,048	979	807
Kern Trinidad	4,721	4,684	5,523
Lobitos	25,260	26,141	25,420
Phœnix	50,433	44,532	38,594
St. Helen's Petroleum	5,389	5,592	5,147
Steaua Romana	85,580	87,120	—
Tampico	2,727	1,471	2,549
Tocuyo	1,924	1,911	1,619
Trinidad Leaseholds	18,600	16,550	13,050

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	Nov. 10, 1931.			Dec. 10, 1931.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		8	0		6	0
Anglo-Egyptian B.	1	5	9	1	2	6
Anglo-Persian 1st Pref.	1	4	6	1	2	9
,, ,, Ord.	2	0	6	1	10	6
Apex Trinidad (5s.)		9	6		9	0
Attock		15	0		15	6
British Burmah (8s.)		3	0		4	0
British Controlled ($5)		1	6		1	3
Burmah Oil	2	1	3	1	14	3
Kern River Cal. (10s.)		1	9		1	9
Lobitos, Peru	1	1	9		18	0
Mexican Eagle, Ord. (4 pesos)		6	3		6	0
,, ,, 8% Pref. (4 pesos)		6	9		6	6
Phœnix, Roumanian		4	9		3	6
Royal Dutch (100 fl.)	15	0	0	13	10	0
Shell Transport, Ord.	2	1	3	1	14	3
,, ,, 5% Pref. (£10)	9	0	0	8	15	0
Steaua Romana		4	9		4	3
Trinidad Leaseholds	1	1	3	1	0	0
United British of Trinidad (6s. 8d.)		3	6		2	6
V.O.C. Holding	1	1	9		16	3

PRICES OF CHEMICALS. December 9.

These quotations (some of which are affected by the devaluation of the pound sterling) are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	17	3
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	6	15	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	24	10	0
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	11	0	0
,, Sulphate, 94%	,,	7	15	0
Benzol, standard motor	per gal.		1	3½
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	,,	15	10	0
Boric Acid	,,	25	0	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		1	9
,, ,, crystallized, 40°	per lb.			6
Carbon Disulphide	per ton	19	10	0
Citric Acid	per lb.		1	1½
Copper Sulphate	per ton	18	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5
Cresylic Acid, 98-100%	,,		1	9
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	8	7
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	4	0
Lead, Acetate, white	,,	44	0	0
,, Nitrate (ton lots)	,,	28	10	0
,, Oxide, Litharge	,,	31	0	0
,, White	,,	40	10	0
Lime, Acetate, brown	,,	7	0	0
,, ,, grey, 80%	,,	10	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	1
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	7	6
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	per cwt.	2	5	0
Potassium Bichromate	per lb.			5½
,, Carbonate, 96/98%	per ton	28	10	0
,, Chlorate	,,	34	0	0
,, Chloride 80%	,,	11	5	0
,, Ethyl Xanthate	per 100 kilos	7	0	0
,, Hydrate (Caustic) 88/90%	per ton	37	0	0
,, Nitrate	,,	20	0	0
,, Permanganate	per lb.			6½
,, Prussiate, Yellow	,,			8½
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	12	10	0
Sodium Acetate	,,	20	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	29	0	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	6	10	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	8	10	0
,, Phosphate, comml.	,,	13	0	0
,, Prussiate	per lb.			5½
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	6
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	2	17	6
,, Sulphide Conc., 60/65%	,,	10	10	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	12	0	0
,, Roll	,,	12	10	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.		1	1½
Turpentine	per ton	54	10	0
Tin Crystals	per lb.			10½
Titanous Chloride	,,			10½
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	10	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Nov. 10, 1931. £ s. d.	Dec. 10, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	3 3 0	3 8 9
City Deep	6 3	5 6
Consolidated Main Reef	1 2 0	1 4 9
Crown Mines (10s.)	5 2 6	5 8 9
Daggafontein	2 13 0	2 17 0
Durban Roodepoort Deep (10s.)	18 0	19 0
East Geduld	3 5 6	3 8 0
East Rand Proprietary (10s.)	15 6	14 6
Geduld	4 6 6	4 14 6
Geldhenhuis Deep	11 3	12 6
Glynn's Lydenburg	5 0	5 0
Government Gold Mining Areas (5s.)	1 15 0	1 16 3
Grootvlei	1 9 6	1 8 9
Langlaagte Estate	1 7 6	1 7 6
Meyer & Charlton	1 0 6	1 2 0
Modderfontein New (10s.)	2 13 9	2 18 9
Modderfontein B (5s.)	11 3	13 3
Modderfontein Deep (5s.)	19 6	1 2 3
Modderfontein East	1 10 0	1 12 6
New State Areas	2 11 6	2 15 6
Nourse	17 3	18 0
Randfontein	1 8 3	1 7 9
Robinson Deep A (1s.)	16 3	16 3
,, B (7s. 6d.)	11 6	11 3
Rose Deep	7 0	2 0
Simmer & Jack (2s. 6d.)	4 3	4 3
Springs	3*10 6	3 18 0
Sub Nigel (10s.)	3 11 6	3 17 6
Van Ryn	11 6	12 0
Van Ryn Deep	1 3 0	1 4 3
Village Deep (9s. 6d.)	2 3	2 6
West Rand Consolidated (10s.)	11 6	11 9
West Springs	14 6	15 0
Witwatersrand (Knight's)	11 6	11 6
Witwatersrand Deep	4 3	4 6
RHODESIA:		
Cam and Motor	1 6 3	1 8 9
Gaika	3 6	3 6
Globe and Phœnix (5s.)	12 0	14 3
Lonely Reef	15 0	16 3
Mayfair	4 6	4 6
Rezende	1 2 6	1 2 6
Shamva	1 0	1 0
Sherwood Starr (5s.)	13 0	12 0
GOLD COAST:		
Ashanti (4s.)	1 16 6	2 0 6
Taquah and Abosso (5s.)	5 0	6 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 9	2 9
Great Boulder Propriet'y (2s.), W.A.	1 9	1 9
Lake View and Star (4s.), W.A.	9 0	8 3
Sons of Gwalia, W.A.	5 9	5 0
South Kalgurli (10s.), W.A.	12 3	12 9
Waihi (5s.), N.Z.	14 6	14 9
Wiluna Gold, W.A.	10 0	9 0
INDIA:		
Balaghat (10s.)	3 3	3 0
Champion Reef (10s.)	8 0	9 3
Mysore (10s.)	8 0	7 9
Nundydroog (10s.)	16 0	17 6
Ooregum (10s.)	3 9	3 9
AMERICA:		
Camp Bird (2s.), Colorado	3	6
Exploration (10s.)	2 3	2 6
Frontino and Bolivia, Colombia	11 3	16 3
Mexican Corporation, Mexico (10s.)	5 3	3 9
Mexico Mines of El Oro, Mexico	1 6	1 6
Panama Corporation	11 0	8 3
St. John del Rey, Brazil	17 3	18 9
Santa Gertrudis, Mexico	10 0	6 9
Selukwe (2s. 6d.), British Columbia	1 9	2 0
MISCELLANEOUS:		
Chosen, Korea	6 0	6 3
Lena Goldfields, Russia	6	6
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	4 3	3 6
Esperanza Copper	13 9	13 9
Indian (2s.)	1 3	1 0
Loangwa (5s.), Rhodesia	2 3	1 9
Luiri (5s.), Rhodesia	3 3	4 0
Messina (5s.), Transvaal	7 0	5 6
Mount Lyell, Tasmania	18 0	17 6
Namaqua (£2), Cape Province	4 6	3 9
Rhodesia-Katanga	11 3	11 3
Rio Tinto (£5), Spain	18 2 6	15 10 0
Roan Antelope (5s.), Rhodesia	13 3	9 3
Tanganyika Con.	1 0 0	15 6
Tharsis (£2), Spain	2 10 0	7 6

LEAD-ZINC:	Nov. 10, 1931. £ s. d.	Dec. 10, 1931. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	12 6	13 0
Broken Hill, North, N.S.W.	2 16 3	2 10 0
Broken Hill South, N.S.W.	1 17 6	1 13 9
Burma Corporation (10 rupees)	10 6	8 3
Electrolytic Zinc Pref., Tasmania	16 3	17 6
Mount Isa, Queensland	12 6	11 6
Rhodesia Broken Hill (5s.)	1 3	1 3
San Francisco (10s.), Mexico	11 0	9 6
Sulphide Corporation (15s.), N.S.W.	10 6	8 6
ditto, Pref.	12 6	10 6
Zinc Corporation (10s.), N.S.W.	1 6 3	1 3 9
ditto, Pref.	2 17 6	2 17 6
TIN:		
Aramayo Mines (25 fr.), Bolivia	17 0	16 3
Associated Tin (5s.), Nigeria	5 0	4 0
Ayer Hitam (5s.)	12 0	10 9
Bangrin, Siam	12 6	11 6
Bisichi (10s.), Nigeria	4 6	4 0
Chenderiang, Malay	1 6	1 6
Consolidated Tin Mines of Burma	2 3	2 9
East Pool (5s.), Cornwall	6	6
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 3
Geevor (10s.), Cornwall	2 0	2 0
Gopeng, Malaya	1 12 6	1 12 6
Hongkong (5s.)	14 9	13 0
Idris (5s.), Malaya	6 9	6 6
Ipoh Dredging (16s.), Malay	16 6	16 0
Kaduna Prospectors (5s.), Nigeria	4 0	4 0
Kaduna Syndicate (5s.), Nigeria	11 6	11 6
Kamunting (5s.), Malay	5 9	4 9
Kepong, Malay	10 0	10 0
Kinta, Malay (5s.)	6 9	6 6
Kinta Kellas, Malay (5s.)	5 6	5 6
Kramat Pulai, Malay	1 1 3	1 1 3
Lahat, Malay	5 0	5 0
Malayan Tin Dredging (5s.)	18 0	15 6
Naraguta, Nigeria	6 3	6 3
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	5 3	5 0
Penawat ($1), Malay	1 0	1 0
Pengkalen (5s.), Malay	10 0	10 0
Petaling (2s. 4d.), Malay	8 3	7 6
Rambutan, Malay	6 3	6 3
Renong Dredging, Malay	15 0	15 0
Siamese Tin (5s.), Siam	9 0	8 0
South Crofty (5s.), Cornwall	3 0	2 9
Southern Malayan (5s.)	10 9	9 6
Southern Perak, Malay	1 5 0	1 3 9
Southern Tronoh (5s.), Malay	6 0	6 0
Sungei Besi (5s.), Malay	8 0	7 0
Sungei Kinta, Malay	10 6	10 0
Tanjong (5s.), Malay	7 6	7 0
Tavoy (4s.), Burma	3 9	3 6
Tekka, Malay	13 0	13 0
Tekka Taiping, Malay	12 0	12 0
Temengor, Malay	1 6	1 6
Toyo (10s.), Japan	1 6	1 6
Tronoh (5s.), Malay	13 3	12 6
DIAMONDS:		
Consol. African Selection Trust (5s.)	7 6	7 6
Consolidated of S.W.A. (10s.)	3 3	2 6
De Beers Deferred (£2 10s.)	3 12 6	3 5 0
Jagersfontein	16 9	15 6
Premier Preferred (5s.)	1 5 0	1 5 0
FINANCE, ETC.:		
Anglo-American Corporation (10s.)	9 9	8 6
Anglo-French Exploration	10 0	10 0
Anglo-Continental (10s.)	2 9	2 9
Anglo-Oriental (Ord., 5s.)	6 9	6 0
ditto, Pref.	8 6	8 6
British South Africa (15s.)	19 3	16 6
Central Mining (£8)	5 15 0	5 15 0
Consolidated Gold Fields	16 3	15 0
Consolidated Mines Selection (10s.)	7 0	6 3
Fanti Consols (8s.)	5 3	5 3
General Mining and Finance	16 3	15 6
Gold Fields Rhodesian (10s.)	3 6	3 0
Johannesburg Consolidated	1 5 0	1 2 3
London Tin Corporation (10s.)	12 0	10 0
Minerals Separation	2 2 6	2 0 0
National Mining (8s.)	3	3
Rand Mines (5s.)	2 17 6	2 19 6
Rand Selection (5s.)	9 0	7 9
Rhodesian Anglo-American (10s.)	9 3	7 3
Rhokana Corp.	3 5 0	3 15 0
Rhodesian Selection Trust (5s.)	8 6	7 0
South Rhodesia Base Metals	2 0	2 0
Tigon (5s.)	3 9	3 0
Union Corporation (12s. 6d.)	2 15 6	2 13 9
Venture Trust (10s.)	4 6	4 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers: also notices of new books and pamphlets, lists of patents on mining and metallurgical subjects, and abstracts of the yearly reports of mining companies.

GOLD ORE-DRESSING PROBLEMS

A discussion of some of the problems encountered in choosing a method of milling to recover gold from various classes of ore appears in the *Canadian Mining and Metallurgical Bulletin* for November, the article being contributed by the staff of the Canadian Department of Mines, Ottawa. For the purposes of the paper the more common types of gold ores are classified from a metallurgical point of view as follows:—

Class 1—*A*.—Free-milling ores which require only relatively coarse crushing.

B.—Free-milling ores which require finer grinding to release the gold.

Class 2—*A*.—Gold ores which contain the gold partly in the free state and partly associated with a small amount of iron sulphide, and which do not require fine grinding.

B.—Gold ores similar to 2*A*, but which require fine grinding.

Class 3—*A*.—Gold ores containing copper in quantities insufficient to interfere to a serious extent with cyanidation.

B.—Gold ores containing copper in sufficient quantity to interfere with cyanidation but in which a large proportion of the gold is in the free state, the remainder being chiefly associated with the copper mineral, chalcopyrite.

C.—Gold ores containing copper and other sulphides, such as pyrite, etc., in which the gold is principally associated with these sulphides.

Class 4—*A*.—Arsenical gold ores in which the gold is partly free, the remainder being associated with, and loosely held in, the arsenical-pyrite.

B.—Arsenical gold ores in which the gold is finely divided and disseminated in the arsenical-pyrite mineral itself. These ores as a rule are very refractory.

Class 5.—Gold ores containing interfering slimes, such as carbonaceous graphitic mineral, soluble salts, etc.

This classification is far from complete, but it is believed to be ample for a paper limited in its scope.

Ores of Class 1.—The first class of ores to be considered comprises the so-called free-milling types, and particularly those of class 1*A*, in which the gold can be freed by relatively coarse crushing. Amalgamation is adaptable to this type of ore, particularly where the gold is coarse. Although the process is comparatively simple, too much stress cannot be laid on the importance of having careful metallurgical tests made prior to the erection of a mill, as this is the only way to determine if the ore is free-milling and also how fine it must be crushed in order to free the economic gold.

Various types of machine have been devised to crush and prepare the ore for amalgamation, but without doubt the stamp mill is the best machine for preparing ores containing coarse gold. It is particularly adaptable to ores which have to be crushed to only 20 to 35 mesh. If the ore is clean, inside and outside stationary plates will recover much of the gold, but it will generally be found that blankets of either corduroy or silence cloth will recover additional gold. Right or wrong, popular opinion is against the use of stamps and in favour of the more simple ball-mill. However, the ball-mill, to be efficient as a crusher, requires to be operated in closed circuit with either screens or a classifier; and it has been the experience of the Mines Department that a ball-mill does not prepare the ore properly for amalgamation, particularly if the ore is ground in closed circuit with a classifier and the overflow amalgamated. The difficulty can be overcome, however, by placing the amalgamating plates between the ball-mill discharge and the classifier. A suggested flow-sheet, which has given satisfactory results at two properties, is as follows: The ball-mill discharge is elevated over a double-deck vibrating screen, with one coarse screen to take the wear off the finer under screen, allowing, say, a −14 mesh material to pass over rather steeply inclined plates. The plate tailing goes to a mercury trap and then to the classifier. The oversize of the screens goes back to the ball-mill with the oversize of the classifier. The classifier overflow can be treated in a number of different ways, depending on the character of the ore and local conditions. In this case, blankets can be used to advantage and might even replace the plates entirely.

In considering ores of class 1*B*—free-milling ores which require fine grinding—the size of the mine and the local situation are important. In the initial stages of the development of a property, it is often found expedient to put in a 50- to 100-ton mill. If, after thorough metallurgical tests, the ore is found to give 80 to 85% recovery by amalgamation by grinding to 60 to 70% −200 mesh, then a study of the costs, including capital outlay, will probably show that an amalgamation plant such as suggested above will yield the largest return to assist development. A cyanide mill

would recover more gold, but it is doubtful whether a 100-ton cyanide plant would show a true profit, when the capital expended on the property is taken into consideration, unless the ore were high grade. This situation is entirely altered if the property has been developed to the point where 200 to 300 tons of ore a day can be assured. Then, if it has been found that the ore is amenable to cyanide, an all-cyanide mill is indicated.

Ores of Class 2.—Gold ores of the second class, namely, ores which contain the gold partly in the free state and partly associated with a limited amount of iron sulphides, vary widely in respect to the way in which they respond to different methods of treatment. This class of ore is subdivided into two main types: 2*A*, ores in which the gold and sulphides are freed at, say, 50 to 70% –200 mesh grinding; and 2*B*, ores which require 75 to 90% –200 mesh or finer grinding. Metallurgical tests will probably show that both these types of ore respond almost equally well to a number of different methods of treatment, such as the following:—

(1) Straight cyanidation.

(2) Flotation, and cyanidation of the flotation concentrate.

(3) Gravity concentration and flotation combined and cyanidation of the concentrate. In the case of (2) and (3), the concentrate might be shipped to a smelter. It will also generally be found that 40 to 60% of the gold can be recovered by amalgamatiou.

(4) Flotation of a coarse feed, –35 mesh or –48 mesh, and classification of the flotation tailing to discard, say, the –65 or –100 mesh material, which might be so low in gold as not to warrant further treatment. In one particular case in mind, 65% of the ore could be discharged at this point, leaving 35%, which included the flotation concentrates and +65 mesh sands, to be cyanided.

Very careful metallurgical tests are required before the most economical method of treatment can be determined, considering at the same time the local situation. Probably the simplest method of discussing this problem is to take specific examples. At the MacIntyre, flotation followed by the re-grinding and cyanidation of the concentrates has displaced the all-cyanide practice. The first point to bear in mind is that the MacIntyre mill has a capacity of 2,000 tons or more. The costs of cyanidation were definitely known, as well as the recovery. Experimental tests, followed by pilot-plant tests, showed that, by a system of two-stage flotation—in which the ore was first ground to about 30-mesh and floated and the flotation tailing, after classification, was again ground and floated—a higher recovery could be made in a flotation concentrate representing about 25% of the ore than was obtained by straight cyanidation. The points of interest regarding the metallurgical character of the ore are, first, that the free old is not coarse, and, second, that the metallic gold floats much better if it has not been flattened out, as it is by the ball-mills. In other words, quite coarse gold will float provided it still retains to some extent the natural ragged form in which it is present in the ore. The over-all recovery, after re-grinding the concentrate and cyaniding, it, was said to be about the same as in all-cyanide practice, and at the time it was hoped that a lower operating cost could be obtained, in addition to the lower costs naturally expected in a new mill.

A point to be emphasized is that, just because one plant makes a successful change, it does not follow that all other gold mills should copy the flow-sheet. The actual conditions should be clearly understood. In the case of MacIntyre, they had to build a new mill anyway. The question was: Recovery and operating costs being about equal, which type of mill would cost the less—straight cyanidation or combined flotation and cyanidation? The answer was the combination mill; but then, as already mentioned, it must be remembered that this was a 2,000-ton mill.

Consider now the case of another mine just going into production, where it was decided to erect a 500-ton mill, with possibilities of further expansion. In this case the ore was carefully tested by four different parties, and the opinions of other outside men were obtained. The ore was of the same class as that of MacIntyre. It contained, however, some quite coarse free gold and about 6 per cent of sulphides carrying gold. The test-work showed that, at –40 mesh grinding, straight cyanidation gave a 10-cent lower tailing than flotation and tabling, and cyanidation of the concentrate. The cyanide consumption was very low, so the chemicals required for either method cost about the same. The 10-cent advantage of straight cyanidation was based on comparison with the best flotation results—but it is only proper to add that the results obtained by flotation varied considerably. For a mill of the proposed relatively small tonnage, the operating costs figured slightly higher for the combined method. It was estimated that the straight cyanide plant would cost $50,000 more than the combined plant. Straight cyanidation was recommended and installed, and both practice and additional experimental work on the ore obtained after further development at the mine have confirmed the wisdom of this choice, the reasons for which were as follows:—

(1) There was an estimated saving of 10 cents per ton on the grade of ore tested, despite the additional $50,000 cost of the mill.

(2) The straight cyanide plant is the more simple and it should be possible to operate it a large percentage of the time, besides which it is a well known standard process.

(3) With a combined plant, it would be necessary to engage or train two classes of operators, some for cyanide and some for flotation.

(4) Because of the probability that, should there be a change in the character of the ore on further development of the mine, the new ore would not respond as well to flotation as to cyanidation.

(5) Because a very few minutes of inefficient operation of the flotation cells might result in high losses, and a spill of concentrates worth about 5 cents per lb. would be quite costly.

Recently an increase in tonnage was contemplated at this mine and further test work was performed on the ore. This test work was done primarily with two objects in view, to determine whether or not, as a preliminary step before cyanidation, a portion of the ore could be discarded at a relatively coarse size—that is, between 20 and 40 mesh—first, by some means of classification and tabling, and second, by flotation. This test work showed that the ore had changed considerably. It also showed that, in order to obtain as high a recovery by flotation as by straight cyanidation, it would be necessary to grind much finer (–65

mesh as compared with –40 mesh). In other words, the cyanide would dissolve gold which was not altogether freed from the gangue, whereas to recover this gold by flotation the ore must be crushed fine enough to free it. It is almost unnecessary to state that it was found impossible to discard any coarse material prior to cyanidation. The test work, however, did indicate that, by a coarse flotation previous to cyanidation, and by classifying the flotation tailing, all the –65 mesh flotation tailing could be discarded, and this, in the laboratory tests, represented over 60% of the original ore. Thus, all that remained to be cyanided was the flotation concentrate, and the coarse sands (+65 mesh) from the classifier. In order to increase tonnage, it would only be necessary to put in additional grinding mills and flotation equipment.

Owing to the popular swing to flotation, it has been found necessary a number of times to endeavour to compare the merits of installing a combination flotation and cyanide mill or a straight cyanide mill at some small property where the initial mill would be only 100 to 200 tons capacity. The concentration ratio obtained by flotation is, of course, of vital importance; but briefly, experience has been that, given an ore with a reasonable concentration ratio, and the same recovery by either method, we have been unable to show that either the cost of the mill or the operating costs would be lower for the combined plant than for straight cyanidation; in fact they are generally decidedly in favour of the latter. Of course, there may be exceptions to this rule, but so far we have not met with them. What has been written above will practically cover the case of ores of the type classified as 2*B*.

Ores of Class 3.—The third class comprises gold ores containing copper. An endeavour has been made to divide these into three sub-classes, but as often as not ores are found which are on the border-line between these.

Class 3*A* ores can naturally be treated as straight gold ores, the only difference being that flotation and cyanidation of the concentrate generally can be ruled out, as the concentrate will contain all the copper mineral. The cyanide consumption will be somewhat higher than for straight gold ores, and greater care will be required to prevent excessive fouling of the solutions. Classes 3*A* and 3*B* merge into one another and great care should therefore be taken to determine the extent to which the cyanide solutions are fouled by the copper after a cycle period, and also to ascertain the cyanide consumption, which is directly affected by this. As a general rule, copper in excess of 0·5% will cause serious trouble, and, if at all possible, it is better to consider amalgamation of the free gold followed by flotation of the copper. In the majority of such ores, most of the gold can be recovered in the flotation concentrate, and what does not float can be either amalgamated from the flotation tailing or caught in a table concentrate. The choice of amalgamation, either before or after the flotation of the copper, will depend on whether it is more economical to have as much gold as possible in the copper concentrate or as little as possible. We have had occasion to give this matter considerable attention and, on every ore of this particular type so far tested, a study of the smelter returns has shown that amalgamation should precede the flotation. In other words, it pays better to recover as much gold as possible at the mine. This has held good even when the mine has been in close proximity to a smelter.

Two examples of such ores may be cited. The first of these had the following composition :—

Gold	. .	0·38 oz. per ton
Copper	. .	0·50 per cent
Iron	. .	6·80 ,,
Al_2O_3	. .	2·86 ,,
CaO	. .	0·90 ,,
MgO	. .	1·55 ,,
S	. .	2·00 ,,
SiO_2	. .	79·00 ,,

After considerable experimental testing it was found that the ore had to be ground to at least 80% –200 mesh. At this grinding, and using the flow-sheet previously suggested for amalgamating a ball-mill discharge, it was found from small, continuous pilot-plant tests that 47% of the gold could be recovered on plates and an additional 39% in a flotation concentrate assaying 9·45% copper and 4·00 oz. per ton gold, with a ratio of concentration of 21 : 1. Flotation alone gave 86% recovery with the same grinding, but the ratio of concentration was much lower, 9 : 1, and the grade of the concentrate was copper 4·65% and gold 3·05 oz. per ton. The recovery of copper in each case was over 95%. A study of the freight and smelter returns showed more than a dollar per ton in favour of amalgamation.

In the second example, the ore contained 1·57% copper, and 1·85 oz. per ton gold, together with some pyrite and pyrrhotite. Experimental tests showed that cyanidation of the raw ore was out of the question. By grinding to 80% –200 mesh, straight flotation recovered over 90% of the gold and 98% of the copper in a concentrate assaying 16% copper and 15·5 oz. per ton gold, with a ratio of concentration of 10 : 1. With the same grinding, amalgamation recovered above 75% and, followed by flotation with a concentration of better than 15 : 1, gave a 15% additional recovery of the gold on a concentrate assaying 22% copper and 3·20 oz. per ton gold. The total recovery was: copper, over 90%; gold, 91%.

Class 3*C* ore, in which the gold is principally associated with the chalcopyrite and other sulphides, is undoubtedly a flotation proposition, with the possibility of making a selective copper float having a tailing low enough in copper to cyanide.

Ores of Class 4.—Ores of class 4, which contain arsenic, vary greatly in their response to metallurgical treatment. There are cases where ores containing as high as 5 to 10% arsenic can be treated successfully, with high recoveries, by amalgamation and cyanidation; others will give only 30 to 40% extraction even with a combination of the two methods. The former type has been classified as ore which contains the gold both free and also loosely held in the arsenical-pyrite and pyrite (class 4*A*); the latter as ore in which the gold is very refractory, being very finely divided and disseminated in the arsenical-pyrite or pyrite (class 4*B*). Typical examples of the first type are the ores at Hedley, B.C., and Brookfield, N.S. In both cases, the ore will cyanide readily without fine grinding. In the case of an arsenical ore in which 30% or 40% of the gold can be recovered by amalgamation, it will probably pay to amalgamate before cyanidation, as clean unoxidized ore will not foul the plates.

The following is an example of the refractory type of arsenical ore (class 4*B*). The analysis of this ore was as follows: Gold, 1·68 oz. per ton; arsenic, 5·96%; nickel, 0·06%; cobalt, 0·08%; bismuth and tellurium, none. A considerable amount of research work was done on this ore. It was found that, by grinding the raw ore to 80% –200 mesh, 40% of the gold could be amalgamated. By grinding the roasted ore to the same degree, only 24% could be amalgamated. Cyanidation at –200 mesh grinding recovered only 35% in the raw ore after agitation for 72 hours. This result was the best obtained on the raw ore, despite the use of oxidizers and many variations in the reagents. The cyanide consumption was about 2 5 lb. per ton of ore. A series of roasting tests was conducted. Dead roasting improved the results only slightly. The effect of adding lime to the charge, both before and after roasting, to convert the arsenic to calcium arsenate, was investigated. The ore was also given a preliminary treatment with acid and alkaline solutions, but without any beneficial effect. A series of controlled roasting tests was made. With a roast controlled so that about 17% of the weight of the ore was volatilized and the residue then ground in water to 80% –200 mesh, filtered, and the cyanide added and agitated for 43 hours, it was found that a maximum recovery of 77% was obtained, using 10 lbs. lime per ton, and in a cyanide consumption of 7·8 lb. per ton. This result was obtained with a low-temperature roast in which the maximum temperature was 780°C. This roast also eliminated the greatest amount of arsenic. A tabulation of the tests showed that the percentage of recovery varied inversely with the arsenic remaining in the ore after roasting. This was as far as the work on this particular ore was carried, and at its conclusion the problem of treating the ore still remained unsolved.

Ores of Class 5.—This class includes ores from all the above classes which contain interfering gangues, such as graphite or carbonaceous matter, or soluble salts which have the property of consuming cyanide. Each ore of this class presents a combination of problems and it is very difficult if not impossible to generalize on the methods of treatment.

In the treatment of graphitic ores which must be cyanided, there are at present three possible procedures. The first of these consists in a preliminary flotation of the carbonaceous matter. The high gold content of tailing obtained from the cyanide treatment of graphitic gold ores is probably due to the carbonaceous material itself carrying gold rather than to actual pre-precipitation of dissolved gold. If a differential flotation is made on the carbonaceous material, the concentrate will practically always be found to be very rich and to contain quite a large proportion of the gold. This is the great drawback to a preliminary differential flotation, as this concentrate must then be either sent to a smelter or given a roast and cyanided, depending on the economics of the two methods. The main bulk of the ore, after the graphite is removed, can be cyanided. The second method would be to float all the gold and gold-bearing sulphides along with the carbon, and then roast and cyanide the concentrate. There is also the possibility that this concentrate might be capable of direct cyanidation, using a very strong solution with excessive aeration for rapid dissolution of the gold; and, of course, there is the alternative of sending the concentrate to a smelter, but only as a last resort. A third method is a pre-treatment with either sodium sulphide or oil, to inhibit the precipitating effect of the carbon. The only hope of these processes being effective is when the carbonaceous material does not itself carry gold. Sodium sulphide or oil might then be used successfully to inhibit the remaining carbon. In some instances this carbon is in the wall rock, and when such is the case every means possible should be taken to prevent this material getting into the mill. It would seem hardly necessary to add that amalgamation should be used when at all practicable, prior to any further treatment.

Ores containing soluble salts which act as cyanicides require special treatment, but only one method will be referred to here—that of crushing the ore in water and thickening or filtering to eliminate the soluble salts prior to the addition of the cyanide solution.

The profitable treatment of low-grade ores largely depends on the sorting out of waste rock before the milling process starts. Laboratory tests made at a distant point cannot be expected to determine this possibility, because as a rule the samples submitted are too small. The only safe method of arriving at a reliable estimate of the amount of waste which can be sorted is to open up some test stopes at the mine and set up an experimental picking belt.

Some Recent Developments.—In concluding these remarks brief reference is given to some recent development in the metallurgy of gold and to some rather important experimental work now being carried on. In at least two of the mills in northern Ontario, a study of the solution of the gold has been made. In general, about 70 to 80% of the gold is dissolved in the grinding circuit, and it has been found that the remaining recoverable gold is mostly extracted in the filters, only a small proportion being dissolved during the lengthy treatment in agitators and thickeners. There is, therefore, the possibility that a saving in the cost of treatment might be effected by introducing a third filtration step in place of the long agitation period. The Genter thickener, which has proved so satisfactory at the Howey mill, would have a distinct field in the elimination of this agitation period. It is particularly adaptable for this purpose on account of its filtering operation and the small floor-space required, and also because of the elimination of froth troubles.

There is a very important problem in connexion with the recovery of refractory gold which is locked up in the sulphides that has never been given the attention it demands. This problem arises in the flotation of gold-bearing sulphides and is met with in the Kirkland Lake camp and in some of the ores from northwestern Quebec. How this gold is held in the sulphides we are not prepared to say, but we at least know that it is sub-microscopic, and that ordinary methods of cyanidation will not effect a fair recovery. Work is being carried on at the Lake Shore mine in an effort to solve this recovery problem.

The cyanide regeneration process is again being given serious consideration, and with a better prospect of success, due to the application of new chemical-engineering experience. The Merrill-Crowe process is in operation at Flin Flon, and a new process is under development in England which has bright prospects of being successful.

RAND METALLURGY

The presidential address of Mr. Andrew King given to the Chemical Metallurgical and Mining Society of South Africa, and which appears in the *Journal* for September, dealt with a few general metallurgical considerations and developments, particularly in connexion with the Witwatersrand gold mines. Extracts from the address are given here.

Value of Surface-sorted Waste Rock.—Some 20 years ago a large number of experiments were carried out to determine the gold content of surface-sorted waste rock and the extraction which could be obtained from such material by ordinary methods of treatment. The average assay value found was about 0·5 dwt. per ton and the extraction obtained when tested on a laboratory scale was about 90%. In spite of the low content of the many samples tested at that time, it has been generally assumed on the Witwatersrand that waste rock contains about one pennyweight of gold per ton.

In some recent investigations with a view to improving surface sorting conditions, it was thought advisable to re-determine with reasonable accuracy the average value of the picked waste. At one mine where this question was of considerable importance, the whole of the picked waste was removed without dumping by a contractor and crushed for road-making purposes; it was, therefore, a simple matter to obtain thoroughly representative samples after the rock had been crushed to — 1 in. size. Numerous samples taken from this source over long periods showed that only on rare occasions did the value of the waste rock sorted at that mine exceed 0·5 dwt. per ton, while the average over one year was found to be 0·4 dwt. per ton.

At another mine where the value of the ore was much higher and where it was desirable to practise as close sorting as possible, it was a much more laborious matter to obtain a representative sample of the sorted waste. In this case the initial daily sample, taken by shovel from the bin chutes after the filling of every truck from the bin, weighed several tons and represented some 2½% of the waste tonnage. This was broken down to — 2 in. and the usual operations of mixing, coning, quartering and crushing carried on until the sample was of reasonable size. Over a period of three months the average value was found to be 0·35 dwt. per ton.

Again, at a third mine, where the matter was investigated, but where conditions for obtaining representative samples were rather poor, it was found that over a period of eight months the average value was 0·54 dwt. per ton.

These results confirm the earlier work and it would appear safe to say, therefore, that given reasonably good conditions in preliminary sizing and washing, the assay value of waste rock picked from sorting belts need not exceed 0·5 dwt. per ton, which value is considerably less than is frequently assumed. In passing, the importance of good washing may be emphasized; surprisingly high assays may be found for the fine material which adheres to badly washed waste rock.

Extraction from Low Value Material.—The question of the percentage extraction that it is possible to obtain from low-value material such as waste rock, is naturally not one on which any very definite figure can be given on account of the varying metallurgical conditions at different plants. At one mine where this question was investigated, the value of the original material was 0·35 dwt. per ton, the degree of grinding was 83·7% —90 mesh and the ground product was separated into 48% of sand and 52% of slime. The combined unwashed residue value after treatment following works conditions with decantation treatment for slime, was 0·17 dwt. per ton, showing an extraction of 51% of the original value. On another sample of waste assaying 0·45 dwt. per ton, ground to 71·3% —200 mesh, separated into 30% sand and 70% slime, and using air agitation for slime treatment, the percentage extraction on washed residues was 78%. These results are much lower than those obtained in the earlier experiments and show the importance of following plant conditions on material of the average value sorted; higher percentage extraction is, of course, to be expected as the value of the original material increases, and as the degree of grinding is improved.

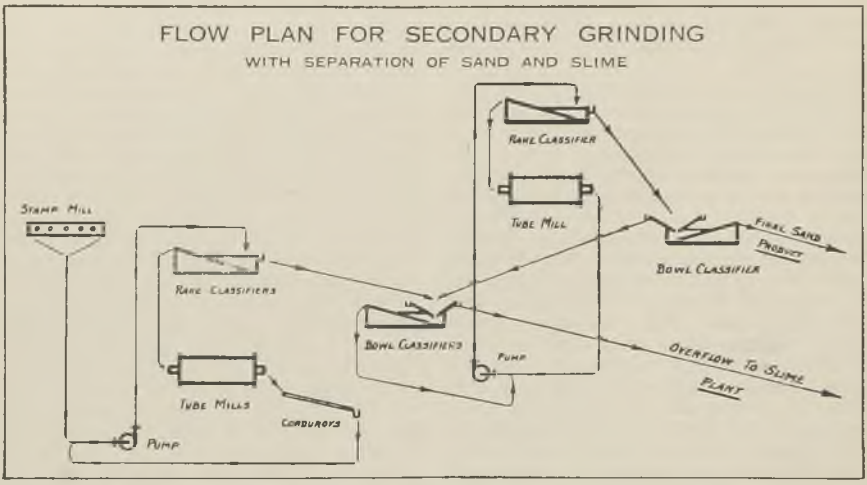
With the constant endeavour to maintain maximum ore tonnage it may be necessary on occasion to investigate sorting efficiency so as to increase if possible the quantity of reef sent to the treatment plant, or to allow better treatment conditions by reducing mill tonnage as the result of eliminating more waste. With the headgear grizzly set at 1¾ in. or more, it will be found frequently that an appreciable amount of sortable waste rock, particularly pieces of flat shape, are included in "fines" going direct to the mill-bin. In one or two cases a very definite improvement has been achieved by separating such material from the grizzly fines on a vibrating screen and delivering it along with the coarse product to the sorting belt. That there is a point at which this fine sorting will no longer be economical will be readily appreciated.

It will be realized that the cost of treating additional tonnage in the reduction plant is one which has to be taken into consideration along with the question of sorting efficiency on the surface. Here again plant capacities and conditions have an important bearing on the subject, so that no hard and fast rule can be laid down, but careful estimates have shown that where existing units have sufficient capacity for some additional tonnage, the cost of treating and handling that additional tonnage in the reduction plant will be about 60% of the normal reduction plant cost per ton. The effect of this additional tonnage on the degree of grinding possible, time of treatment and residue value will also have to be gauged before a complete estimate of the final result can be arrived at.

Cost of Surface Sorting.—The cost of surface sorting of waste is not as a rule the subject of a separate mine account. It is generally included in an account which also covers the cost of breaking and often some portion of the surface transport cost. It may be of interest, therefore, to mention that at one mine where surface sorting has been investigated and where the cost of this operation has been kept separate for some considerable time, the average cost of sorting 7,400 tons waste per month is 10½d. per ton sorted.

Preparation of Ore Feed for Grinding Plant.—During the last year or two notable advances have been made in the mechanical and metallurgical efficiencies of secondary crushers

used for the final preparation of ore feed to the grinding plant. Due largely, no doubt, to the higher speed at which these modern machines are able to operate, not only has the tonnage capacity of similar sized units been greatly increased but the proportion of fine material produced has also been greatly improved. At one mine where generally it was necessary to have three old-type gyratory machines in operation, each driven by a 50 h.p. motor, and with an average running time of 10 hours per day each, it has been found possible in preparing stamp-mill feed to crush the same amount of ore in one of the newer type of machines, consuming 110 h.p., in 10 hours running time. In addition, the new type of machine is capable of being set much finer and the product is crushed to 5% + 2 in. and 25% is $-\frac{1}{2}$ in., whereas under old conditions the crushed product contained 15% + 2 in. and only 15% $-\frac{1}{2}$ in.



The cost of running and maintaining these new machines will vary according to the type of work being done, but it is known to be much less than with the older types for the same amount of crushing. Apart from the question of reduced running and maintenance cost, the advantages to be gained in subsequent operations by delivering a finer product to the mill-bin may be of great importance; in one case it has been possible to undertake large maintenance work in the stamp-mill, involving the hanging of 20-1,500 lb. stamps, without affecting the tonnage milled or the degree of final grinding.

Results of Co-operation in the Gold Mining Industry.—The greatest recent improvement in local metallurgical practice has been the further development of stage tube-mill grinding. This development was the result of the work carried out by Messrs. Willey & Ewing and described in a paper read before this Society in October, 1929, which was summarized in the Magazine for February, 1930. Since the demonstration of the metallurgical and economic success of this departure from ordinary tube-mill practice, the modification of existing circuits and the erection of additional units have been carried out at several mines, and the results in every case, so far as I know, have shown improved grinding efficiencies and lower residue value. It may be mentioned in passing that, where the life of the mine warrants the capital expenditure necessary and where the existing layout of the plant permits a certain amount of alteration, some improvement in extraction will be obtained by adapting two-stage tube-milling to the older type of reduction plant, i.e., one with both stamps and tube-mills and with separate sand and slime plants. The advantages to be gained by preferential grinding of a concentrated product in the secondary tube-mill circuit, therefore, are not confined to the all-tube-mill one-product-pulp type of plant; in the case of the old type of plant the additional classification step for the separation of a final sand product is still, of course, necessary. A flow plan which has been found to give satisfactory results under these conditions is shown in the accompanying figure. Even if cones be used instead of the rake and bowl classifiers indicated, a considerable improvement, as compared with one-stage tube-milling, will be found. At one plant where this circuit was introduced there has been an appreciable increase in the value of the sand original and in the amount of the pyrite which it contains, but on account of the finer grinding and the increased percentage of the total pyrite contained in the finest portion, there has been an appreciable improvement in residue value.

These developments in tube-mill grinding form a good example of the improvements in local practice which are frequently due to the efforts of some one person or company, then to the broadcasting of the results obtained through a society, and afterwards to its adoption in and adaptation to other plants.

One departure from ordinary local tube-mill practice which is being used to an increasing extent, is the use of a composite grinding load (i.e., ore pebbles plus steel balls). Where under ordinary conditions the tube-mill circuit tends to be overloaded and where some additional grinding is called for, the advantages to be gained by using a composite load in a proportion of the mills have been found to more than counterbalance the small additional cost. At one plant a series of tests were carried out using a composite grinding load in a standard tube-mill (22 ft. by $5\frac{1}{2}$ ft.) and comparative data were obtained from another mill of the same size and grinding the same class of

material. The composite load consisted of 75% of pebbles and 25% of 2½ in. steel balls, the proportion of steel balls being maintained by feeding 150 lb. per day. The results showed that there was an increase of over 28% in the amount of −200 mesh material produced for an increase of 17·5% in power consumption and 18% increase in pebble consumption. During the operation of the tests, although carried out on only one-sixth of the tube-mill plant, the whole circuit was operating much more smoothly and there was every visual indication of the improved grinding which the figures showed, and the good effect of the improved grinding became apparent later in lower residue value from the cyanide plant. The results of the tests are in general agreement with those obtained in other plants where it has been found advisable to use composite grinding loads. Given sufficiently powerful motors and ample pebble supply it will be obvious, therefore, that the troubles obtaining in an overloaded tube-mill circuit may be lessened considerably, and better all round results obtained by the use of such a grinding load.

A further development of stage grinding has been put into practice quite recently. It has already been mentioned that two-stage tube-mill grinding has been introduced into several plants with beneficial results. It is of interest, therefore, to note that a further step has been taken in the new plant at East Geduld where operations have recently started, and where, for the first time on the Witwatersrand three-stage tube-milling is being practised. A tertiary grinding circuit is also being arranged in the Daggafontein plant. Since it has been found economically sound to introduce two-stage tube-milling for the grinding of stamp-mill pulp, it follows that where stamps are replaced by tube-mills three stages of grinding are likely to prove equally advantageous.

Regarding cyanide treatment of slime or one product pulp we do not appear to have reached common conclusions as to the most economical or efficient type of units to erect. Intermittent-decanting slime collectors with solution of gold in Pachuca vats followed by Butters filtration plants continue to be erected at the same time as plants which make a feature of continuity of operation in collection, agitation and filtration. One may say, therefore, that with slime treatment as with tube-milling the best combination of units or the best type of plant are matters on which for the present, due to incomplete data, general agreement has not yet been reached.

In general it may be said that, except for grinding in tube-mills instead of in ball-mills, metallurgical development and progress on the Witwatersrand appears to be on lines parallel with those in other large gold mining centres. So far, however, we have not been able to prove any economical advantage on the Witwatersrand in adopting the flotation process to supplement cyaniding, and it is doubtful whether this can be expected since, generally speaking, such a large proportion of the gold is extremely fine and is not associated with the pyrite in the ore, and that once having been exposed by fine grinding solution takes place readily.

The possible use of the flotation process as a step in the treatment of some of the more refractory ore deposits of this country should, of course, be remembered. As an indication of what is possible with certain types of ore, it may be mentioned that at one large mine in Canada it has been decided, in rebuilding the reduction plant, to incorporate the flotation process with a view to discarding 75 to 85% of the ore before finally re-grinding and cyaniding the remaining 15 to 25%. There are, of course, other gold mines in North America and elsewhere at which the flotation process is used in order to facilitate the extraction of gold when it is associated with refractory minerals, and in these cases the flotation concentrate is generally despatched to a smelter for final treatment, or is roasted before cyanide treatment.

THE TREATMENT OF DRILLING MUD

In the drilling of an oil well by a rotary drill, clay and other mud materials may account for up to 25% of the cost of a completed well. The processing of the mud fluids used in such drilling work includes some of the most important applications of physical and chemical engineering principles. The matter is dealt with by M. E. Dice, who is research engineer to the General Petroleum Corporation of California, in *Chemical and Metallurgical Engineering* for November and full extracts from his article are given here. The author points out that in addition to savings in direct costs, mud treatment has substantial insurance value in preventing gas blow-outs and lodged drill pipe, with subsequent damage to the well and equipment.

At an individual well the mud circulating system begins at a mud pit or circulating tank, from which pumps deliver the fluid at pressures frequently as high as 1,500 lb. per sq. in. through a flexible hose and swivel joint into the rotating drill stem. The mud passes down through the drill stem, out through openings in the pit at the bottom of the hole, and upward in the annular space between drill stem and walls of the hole. At the surface again it flows at a slow rate through a series of flumes, ditches, or sumps where sand should settle out and gas escape, the mud returning to the circulating tank. It is discarded or reconditioned when the non-separating sand and gas contents become excessive.

Rotary mud usually is made from natural clays. In many cases, the well "makes" its own mud; in others, suitable materials must be hauled long distances. Four of the principal California clay deposits have been described by E. P. Tallant. Two are in the Mojave Desert, one on Frazier Mountain, and one near Los Angeles harbour. The cost of mud materials in this region, according to H. N. Marsh, averages $13 per rig per drilling day, or about $2,000 per well. Averages from other sources run from $1,200 to $10,000 per well. March reports unit costs varying from 10 cents per barrel of mixed mud where suitable clay is close at hand to $1 where long hauls are involved, and on up to $11 per barrel where heavy weighting materials must be used.

Chemical control of drilling mud began only a few years ago, when the importance of its colloidal properties became apparent. Density control goes back a few more years, but the interrelation of viscosity and density was not understood until the problem was approached from a colloid stand-

point. Although a substantial beginning has been made, full control awaits the development of practical technique and rugged equipment for use at the well. If wells are to be drilled to 15,000 ft., it probably will be necessary to assign a capable engineer to each drilling crew, but at present, efforts are being made to find methods which can be added to the driller's already large bag of tricks.

Mud has various duties to perform at different stages of drilling. For this reason it is impossible to generalize regarding its properties. The first purpose of the mud stream is to remove cuttings as fast as they are formed by the drill. This is largely a function of velocity, which should vary between a rate just sufficient to float the particles and one which begins to scour the sealing film from walls. Since the resultant upward movement of particles equals the linear velocity of the mud stream with respect to the walls minus the settling rate, it would seem advantageous to minimize settling. Stokes' law indicates that a high fluid density and high viscosity retard settling. However, these qualities also retard the separation of sand and gas outside the well and therefore are not really desirable. Settling usually may be counterbalanced by slight increase in mud rate, and as a matter of fact a linear upward velocity of one foot per second is ample to float the largest particles. Another essential function of mud fluid is to provide sufficient pressure to prevent the inrush of gas, oil, and water before the well is completed. Density is the most important property in this case.

In order to prevent a reversal of the essential outward pressure gradient from the well it is important to provide a generous excess of hydrostatic pressure. Too small differential may make it impossible to increase the density fast enough when required to prevent gas from bubbling into the column. Each bubble reduces the average density and the total hydrostatic pressure, thereby permitting more bubbles to enter. The process is cumulative and may lead quickly to a destructive blow-out, although with modern equipment and alert control such instances are rare. At the same time, in providing excess density as a factor of safety against blow-outs and their dreaded menace of fire, one must not go too far, especially in porous formations, else excessive amounts of mud or water will be forced into the structure. Excessive mud penetration may seal an otherwise productive sand so deeply that production cannot be obtained. During idle periods, as while running drill pipe to change the bit or when fishing for lost tools, cuttings should be held in suspension. This is accomplished by a colloidal dispersion which results in a weak gel when movement ceases, becoming fluid again upon agitation.

Mud seals the walls of the hole, decreasing the loss of fluid into porous structures, consolidating loose formations to prevent caving, and sealing off unimportant gas, oil, and water strata without cement. A colloidal dispersion which gels in the pores of the structures is desirable. The penetration of mud into a structure is small.

The movement of casing and drill pipe in the hole is greatly facilitated by a colloidal slime deposited on the walls. The action of protective colloids in coating abrasive material with slime also has lubricating value and decreases wear upon mud pumps and other equipment. Circulating mud removes frictional heat from the bit and lower end of the drill pipe. Temperature, specific heat, and heat-transfer coefficients are important in this connexion to the exclusion of other properties, but are satisfactorily taken care of without special consideration.

Important properties of rotary mud are density, viscosity and shearing strength, colloidal dispersion and graduation of particle size, and surface tension or interfacial tension against gas. They are interrelated under some conditions and independent under others, varying with geological structure and functions of the mud. Because of the innumerable combinations of conditions encountered, it is difficult to specify even ranges of desirable properties.

Density must be sufficient to make the hydrostatic head greater than gas or fluid pressure in the formation by a reasonable factor of safety, but without forcing mud deeply into the structure. Under some conditions, the mud density may be little more than that of water. Under high-pressure conditions, as much as twice the density of water may be required to keep the well under control. The density depends in general upon the concentration and specific gravity of the solids present. Ordinarily, it is increased or decreased by adding clay or water as needed. Viscosity and dispersion must be considered simultaneously with density in most mud functions, the problem being to obtain adequate density, low viscosity as a rule, and a permanent suspension of solids. Combinations of these properties may be obtained, each being suited to the particular pressure, wall structure, and other geological conditions present. Mud density generally is measured by weighing a given volume in a pail on a spring balance. Rusty and inaccurate balances are not unusual, however, and more accurate methods include the use of a modified hydrometer and several types of continuous indicating or recording devices.

Viscosity is an indefinite term when applied to rotary mud of the gel-forming type. Such a suspension is really a plastic and its viscosity varies with characteristics depending on movement or elapsed time since movement ceased. The viscosity and shearing strength of plastics may be determined with an efflux viscometer upon which pressure can be placed. The rate of flow through the capillary is plotted as a function of the differential pressure across it. The pressure intercept, which is the pressure required to start flow, is called yield point and is a measure of shearing strength. Yield point varies with the dimensions of the capillary used, while shearing strength is a property of the plastic. The pressure required to start flow in a pipe may be calculated from the shearing strength of the plastic and dimensions of the pipe. The method is described by Bingham. The point to be emphasized here is that the pressure drop accompanying flow through an orifice is the sum of the pressure required to produce fluidity and that required to produce flow.

A comparison of viscosities measured with an ordinary efflux viscometer upon materials of different yield point and shearing strength has little absolute significance. If care is taken to designate them as "apparent viscosity" under the particular conditions, they are useful in a general way in the field. For rapid measurements, the simple funnel described by Marsh is satisfactory for a comparison of efflux times, which may be

combined with density to obtain apparent viscosity in centipoises.

Farnham collected samples of mud which were judged satisfactory in field operations and determined their apparent viscosities with a Stormer viscometer (100 g-weight). He found 6 to 15 centipoises at 100° F. representative of California practice. Shearing strengths were not stated. They probably were of the order of 0·1 to 1 lb. per sq. ft. for natural clay muds and 1 to 10 lb. per sq. ft. for bentonite mixtures. In some fields, as in Oklahoma, apparent viscosities lower than 5 centipoises are common. This means less than five times the viscosity of water at 68° F. The upper limit recommended by Farnham is 30 centipoises.

It is a common error to confuse viscosity and density. A thick mud is not necessarily a heavy mixture of solids are made, their apparent viscosities and densities measured, and a curve is drawn. A gel-forming colloid such as bentonite increases in viscosity rapidly with concentration. On the other hand, the apparent viscosity of other natural clays increases more slowly with concentration. It is possible, therefore, to obtain almost any combination of density and apparent viscosity by combining solids in various proportions. For careful control, curves of this type should be prepared in the laboratory by the use of the natural clays and proprietary colloids available. Curves of this kind, together with funnel-viscometer readings and simple settlings and gelling tests, are now generally used in the field.

Sand and abrasives cause wear upon pump valves and liners, drill pipe, bits, and other equipment. If means for sand removal other than settling

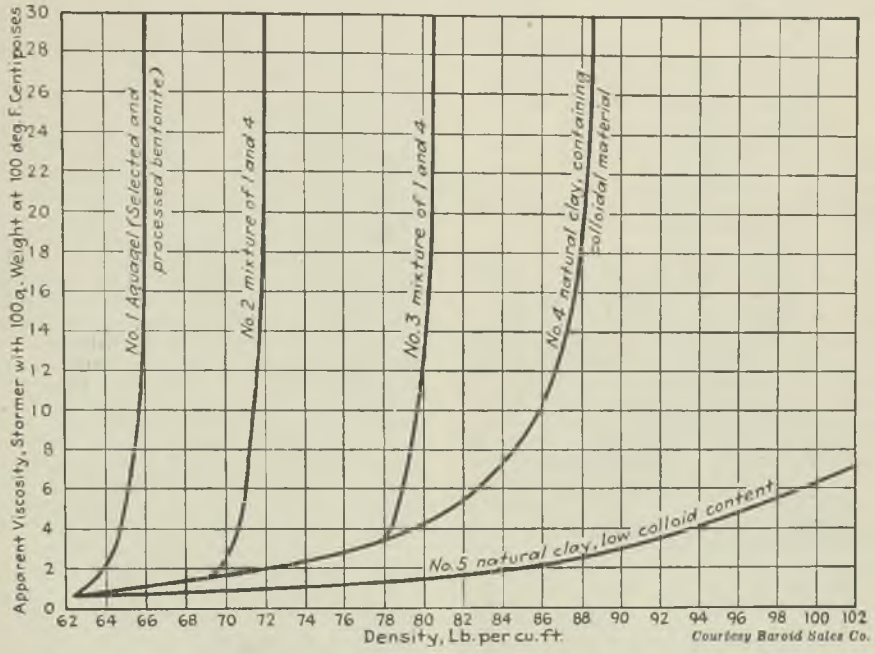


FIG. 1.—CONTROL OF DENSITY-VISCOSITY RELATIONSHIPS BY MIXING SOLIDS FROM TWO OR MORE SOURCES.

mud. Some muds which will scarcely flow have a density only slightly greater than that of water. An important colloidal requirement is that a mud shall be fluid while in ordinary circulation but shall form a plastic gel when motion ceases, thereby preventing even massive particles from settling around the bit.

Surface tension and interfacial tension are important in connexion with gas bubbles. Not enough is known as yet regarding them and their variations and effects upon gas cutting. L. C. Uren has pointed out the need for rapid measurements of this kind at the well and for methods of control which will prevent gas adsorption or foaming.

The most generally useful method in use at present of comparing properties of one material with another is by plotting apparent viscosity as a function of density. For this purpose suspensions containing various proportions of the clay or in flumes are not provided, it is not unusual for mud to be discarded after five or six days of use.

The presence of oil is objectionable because it tends to form viscous emulsions. It is a welcome sight to the driller, however, when it appears for the first time in the mud stream, indicating that oil sands have been encountered.

Gas is undesirable because it lowers the average density of the mud column. When it refuses to separate easily in the flume, the mud is said to be "gas-cut." The condition is thought to be colloidal, since the tendency increases with viscosity, and viscosity, for a given mud density, increases with the degree of dispersion. The driller's practice, when mud shows evidence of gas-cutting, is to jet the stream against a flat plate. Stirring, screening, and spraying have been tried with more or less success. Dilution followed by thickening, as

practised in one central reconditioning plant, is effective.

Processing includes the use of admixtures to control density and viscosity in various proportions, chemical reagents to increase or decrease the dispersion, and mechanical methods of removing sand, gas, and oil. If the required density cannot be obtained without excessive viscosity by adding clay, finely ground barytes usually is added. Densities up to about 85 lb. per cu. ft. may be obtained with ordinary clay ; with barytes or other heavy inert material, densities of 100 to 105 lb. per cu. ft. are common. At a well where gas pressures are expected momentarily, a tank of heavy mud is held in readiness. The driller watches the level in the circulating tank or pit ; when this rises, he knows that gas or liquid is entering the hole, whereupon he switches to heavy mud. Hematite also has been used in considerable quantities as a weighting agent.

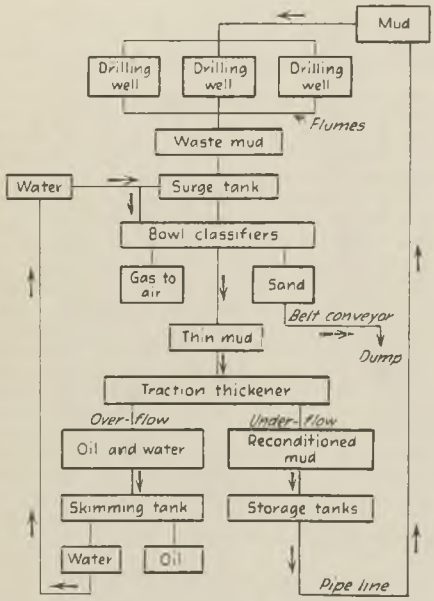


FIG. 2.—MUD RECONDITIONING FLOW-SHEET OF ASSOCIATED OIL CO., AT VENTURA, CALIFORNIA.

Other inert materials are used to increase the dispersion and to act as protective colloids. Many natural clays contain gel-forming colloids in fair quantities, but the best control of density-viscosity relationships is not always obtained without mixing solids from two or more sources. By such mixing almost any combination may be obtained. Selected bentonite is widely used to increase the colloid content and, therefore, the viscosity without proportionately increasing the density. When added to rotary mud, bentonite acts as a protective colloid, coating the larger particles and forming a permanent suspension. Sodium aluminate, one part to 600 parts of mud, also has been employed as a protective colloid.

Well-known discussions of the electrical properties of colloids, the effect of varying concentrations of various ions and adsorption in general need not be repeated. It is sufficient to say that the principles of colloid chemistry apply to rotary mud.

Numerous peptizing electrolytes have been tried with varying success. To find a universal mud-treating compound is, of course, as hopeless as to find a universal water-softening compound. Detailed analytical data regarding mud solids, water, and formations in the well are necessary to plan experiments intelligently.

Since dispersion and flocculation often are reversible, it should be possible to decrease the dispersion as the mud leaves the well, enabling it to drop sand and release gas, and then to peptize it and restore the desired dispersion. Several processes of this general type have been developed, but most of them are quite local in their application.

In some locations, particularly in the Gulf Coast states, shales are encountered which thicken the mud excessively with colloidal material. The problem here is one of decreasing the dispersion. Thinning with water is done at the expense of density and may result in a blow-out. Treatment with sodium tannate has been described and other flocculating reagents include caustic soda, either alone or with organic acids ; sulphuric acid ; hydrated lime ; sodium silicate ; and sodium sulphate. The flocculating effect of sodium chloride is well known. To counteract it in wells which must, for economic reasons, be drilled with sea water, hydrated lime or caustic soda has been added until the pH value is 9 or more. Similar treatment is indicated when salt is encountered in the formation, although it is the usual practice when drilling through thick layers of almost pure salt to put the mud aside and circulate water only.

Mechanical processes include vibrating screens, dilution-classification-thickening, and centrifuging. Other ore-dressing methods probably will make their appearance. The type of equipment depends largely on whether a single well or a group of wells is involved. A few central plants have been built, but in locations where property is scattered in small parcels, individual installations are preferable. The trend of development is toward portable outfits for individual wells, and mud conditioning equipment may become a common adjunct of all drilling wells in the near future.

One successful type of vibrating screen consists of a 30-mesh screen mounted on four coil springs and vibrated by an electric motor. The stroke is about $\frac{1}{8}$ in., obtained without an eccentric arm by placing a small weight on one side of the shaft to unbalance the rotor. The screen receives the flow from the well at the head of the flume. Undersize material drops into the flume while the oversize is flushed away to waste. The combination of rapid shaking and short stroke produces satisfactory separation at low cost and with little attention. Tallant says a 4 by 5 ft. 30-mesh screen at an angle of 15 to 28° will handle up to 700 or 800 bbl. per hour, which is ample for California drilling. The installed cost, he says, is $1,000 to $1,500. Monel metal screens cost $40 and last about 42 days, making a replacement cost of about $1 per day. The useful life of mud has been increased more than ten times by continuous screening. While fine sand is not removed, such particles seem to be sufficiently coated with colloidal material to render them much less abrasive.

Wilfley tables and other ore-dressing equipment are being used experimentally and various combinations or riffles and baffles in the settling flumes also have been introduced.

The most elaborate mud-conditioning plant to

date is that of the Associated Oil Co. at Ventura, California. It originated with a waste-disposal problem. The location is mountainous, and all the available canyons had been dammed and filled with discarded mud. New mud was available at practically no cost from hillside clay deposits on the property; therefore reconditioning became attractive only when the operators were faced with the cost of trucking away sand-laden mud. The plant has been located in the bottom of a canyon. Used mud gravitates to it in flumes from wells on the hillsides. The mud is collected in a 1,000-bbl. tank, from which it flows to a small distributing tank feeding four Dorr bowl classifiers. Diluting water is added in the distributing tank and classifiers. Gas escapes to the air. The sand discharged by the classifiers is carried in belt conveyors to a waste dump, while the thin slime gravitates to a traction thickener. The underflow from the thickener is reconditioned mud; the overflow, water and oil. Mud is stored in two 2,500-bbl. tanks, from which it is pumped back to the wells as required. Oil is skimmed from the water in a skimming tank and the water is recycled.

The process is effective for sand removal, turning out a fluid lower in sand content than freshly mixed hillside mud. It requires little water makeup. The maximum capacity is about 10,000 bbl. per day of 76-lb. fluid, or sufficient to provide 20 wells with a daily change. The cost of treatment varies between 5 and 12 cents per bbl., according to Tallant. A plant of this magnitude could be duplicated in few places because the development programme is seldom so well adapted to a central plant. Moreover, the general process is dependent upon the geological structure for most of the colloidal material in the mud. It is apparent from theoretical considerations that gravity sedimentation cannot increase the concentration of the desirable colloidal matter to what it was before dilution, and such a process, while effective for removing sand, gas, and oil, may accomplish these results at the expense of colloid content. Colloidal material is dispersed on dilution and continues to circulate with the water in the process until it reaches a concentration where some flocculation or coagulation occurs. In this particular location, colloid makeup is obtained from the formation. Where this is not possible, dilution and gravity sedimentation processes may require additional treatment such as flocculation, coagulation, and filtration if colloidal particles are to be returned to the thickened mud.

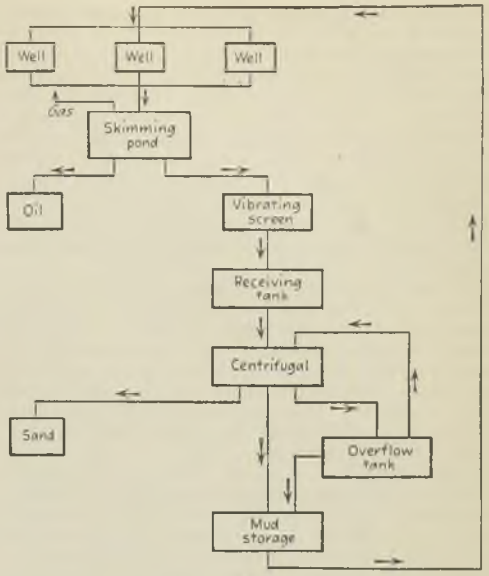


FIG. 3. — CENTRIFUGAL MUD RECONDITIONING FLOW-SHEET OF UNION OIL CO. OF CALIFORNIA AT VENICE.

Centrifugal separation has been applied by the Union Oil Co. of California in central plants at Venice and Santa Fe Springs, Calif. Used mud, after passing through a vibrating screen to remove foreign matter and large particles, passes into a receiving tank. If the mud is contaminated with oil, it first passes through a skimming pond. Separation is effected in a Merco centrifugal rated at 600 g.p.m., sufficient to provide seventeen wells with a daily change. The throughput depends on the separation required, the sharpness decreasing with increasing rates. Sand removal is nearly complete and without loss of colloidal fines. The total investment, including pipe lines, is about $12,000. Based on rates far below capacity, Tallant gives an operating cost exclusive of fixed charges of 16 cents per barrel of mud.

Utah Copper Concentrating Practice.—The concentrating practice of the Utah Copper Company at its Magna and Arthur plants, about 19 miles west of Salt Lake City, is described in Information Circular 6479 of the United States Bureau of Mines, by H. S. Martin. The mine, serving both concentrators, is at Bingham Canyon, 17 miles south of the mills. At the end of 1929, ore reserves were estimated at 640,000,000 tons averaging 1·07% of copper, even though from 1903 to 1929 more than 200,000,000 tons of ore had been mined. The bulk of the ore is monzonite-porphyry containing finely disseminated pyrite, chalcopyrite, chalcocite, covellite, and bornite.

Each concentrator is capable of treating 30,000 tons of ore per day, although for the best metallurgical results a combined daily tonnage of 54,000 is probably the upper limit. A record of 69,200 dry tons of ore handled in one 24-hour period was made during 1929. Prior to 1914, gravity concentrating methods were practised exclusively, the machines used comprising jigs, vanners, and tables. From 1914 to 1926, a combination of gravity and flotation methods was used and since 1926 concentration has been by flotation methods exclusively. The flow sheets of the two concentrators are similar.

A summary of ore treatment at the Magna plant is given as follows: The coarse-crushing plant reduces run-of-mine ore to approximately 1-in. maximum size in two stages. The first reduction is made by a No. 27 gyratory crusher to 6-in. maximum size and the second is by 7-ft. cone crushers. The fine-crushing plant comprises twelve

sections and reduces the ore to approximately minus 6 to minus 10 mesh, depending upon the character and moisture content of the ore, by rolls operating in closed circuit with impact screens. Fine grinding to approximately 10% plus 100-mesh is done in two stages by ball-mills operating in closed circuit with drag classifiers. A bowl classifier is placed between the two stages receiving the finished pulp of the first stage and delivering sand to the second stage and overflow pulp which is joined by the finished ground product of the second stage, both products going to flotation treatment after thickening.

The main flotation plant consists of 60 rows of single spitz mechanical-air machines, each row consisting of 8 rougher cells, 2 primary cleaner cells and 1 secondary cleaner cell. Flotation feed pulp contains between 24 and 26% of solids. Reagents used are lime, sodium aerofloat, raw cresylic acid and cyanide. The flotation concentrate, after thickening, is filtered, the final cake containing about 10% of moisture.

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The use of natural gas in the new process is expected to have many important effects. It is particularly suitable for continuous countercurrent operation permitting high extraction of zinc without interruption. The undesirable formation of blue dust, a mixture of 10% zinc oxide and 90% of impalpable zinc powder, and difficult to control in the older dry processes, can be practically eliminated by it. There is no expense for gas-producer equipment to convert coal to gaseous fuel. The fuel economy is high, as 12,000 cu. ft. of methane at 10 cents per thousand will reduce 1 ton of metallic zinc for which 1 ton of coal would otherwise be required. The possibilities of the new method have been proved by trial at the Rare and Precious Metals Experiment Station at Reno, Nevada.

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Mercury and Manganese Determinations.—In *Industrial and Engineering Chemistry* (Analytical Edition) for October 15, H. H. Willard and J. J. Thompson describe the volumetric and gravimetric determination of mercury as periodate and the volumetric determination of manganese after oxidation by periodate.

Geophysical Prospecting.—A brief description of modern geophysical methods of prospecting, containing special reference to the magnetic and electrical methods, appears in the *Transactions* of the S.A. Institute of Electrical Engineers for September, the author being G. D. Walker.

Mineral Paragenesis.—The use of geometrical contacts in the determination of mineral paragenesis is described by R. D. Harvey in *Economic Geology* for November.

Gold in the Rand Banket.—Vol. xxxiv of the Geological Society of South Africa contains a number of papers relating to the genesis of gold in the Rand Banket, originating in the controversial paper of Prof. L. C. Graton which was reviewed in the MAGAZINE for July, 1930, and to which reference was made in August last.

Sodium Sulphate in Canada.—The sodium sulphate deposits of Saskatchewan are described by J. P. de Wet in the *Canadian Mining Journal* for November.

Bauxite in Brazil.—F. W. Freise describes bauxite deposits in the State of Minas Geraes in *Metall und Erz* for November 1.

Analysis of Concrete.—The analysis of set concrete is discussed by W. T. Cooke, W. St. B. More, G. S. Dick, and T. W. Dalwood in the *Chemical Engineering and Mining Review* of Melbourne for October 5.

Mining at Gilman, Colorado.—In *Engineering and Mining World* for November there appears a description of mining and milling methods at Gilman, Colorado, prepared by the technical staff of the Empire Zinc Company.

Gem Mining.—S. H. Ball gives some historical notes on gem mining in *Economic Geology* for November.

Low-Temperature Distillation of Coal.—In a paper read before the Third International Conference on Bituminous Coal held at Pittsburgh, United States, R. V. Wheeler described the Salerni system of low-temperature carbonization, while at a meeting of the Institution of Engineers and Shipbuilders held in Glasgow last month, E. H. Smythe and E. G. Weeks described the new Babcock retort at the Dunston Power Station. Both papers are summarized in the *Iron and Coal Trades Review* for November 27.

RECENT PATENTS PUBLISHED

☛ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending* 1s. *to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.*2, *with a note of the number and year of the patent.*

9,905 of 1930 (357,993). P. Spence and Sons, and A. Kirkham, Manchester. Solutions of alkali monocarbonates are used in the treatment of silicate residues, substantially pure silica being obtained without the addition of alkali acid carbonate or carbonic acid.

9,970 of 1930 (357,967). Dorr Co., New York. The separation of finely divided suspended solids from solution is effected by first adding a precipitant or flocculating agent, agitating by means of paddles rotating at a fixed speed, and allowing the whole to settle.

16,348 of 1930 (358,039). O. Gerlach, Peru, Illinois. Zinc ores are crushed and wetted, part of the ore being then heated so that the vapours are condensed in ore, the batch already treated being separated, the whole process simplifying the purification of such ores.

20,097 of 1930 (358,546). C. F. Richards, White Haven, Pennsylvania. Hydraulic coal and ore washing and separating machines.

20,673 of 1930 (358,935). K. von Szombathy and K. Kell, Budapest and P. Schmitz, Dortmund. Sulphur gases are treated by tetra- and pentathionate solutions, which take in sulphur which is subsequently precipitated, the solutions being returned to the absorption plant.

31,632 of 1930 (357,814). Odda Smelteverk A/S and E. Johnson, Odda, Norway. Phosphate rock is treated by nitric acid, calcium nitrate being separated from the resultant phosphoric acid solution.

33,848 of 1930 (358,329). S. Hunter, Penzance. An apparatus for the extraction of dust from minerals such as coal.

36,709 of 1930 (358,794). A. C. Jessup, Clamast, Seine. Magnesium is electrolytically produced from a mixture of potassium and magnesium chlorides.

39,155 of 1930 (359,309). Hirsch, Kupfer-und Messingwerke A.G., Germany. The melting of electrolyte copper in an electric furnace is found to eliminate gases which otherwise contaminate the copper and produce bad castings.

11,315 of 1931 (358,863). Patentaktiebolaget Grondal-Ramen, Stockholm. Sulphur-arsenic gases obtained from the roasting of ores in shaft furnaces are condensed in a system from which air is excluded, the product being an easily-handled powder.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C. 2.

Determinative Mineralogy. A manual with tables. By J. Volney Lewis. Fourth edition revised by A. C. Hawkins. Cloth, octavo, 230 pages, illustrated. Price 18s. London: Chapman and Hall; New York: John Wiley.

Chemical Analysis of Iron and Steel. By G. E. F. Lundell, J. I. Hoffman, and H. A. Bright. Cloth, octavo, 641 pages, illustrated. Price 42s. London: Chapman and Hall; New York: John Wiley.

Petroleum in the United States and Possessions. By R. Arnold and W. J. Kemnitzer. Cloth, octavo, 1052 pages. Price 63s. London: Harper and Brothers.

Water Diviners and their Methods. By Henri Mager. Cloth, octavo, 308 pages, illustrated. Price 16s. London: G. Bell and Sons.

Elements of Optical Mineralogy. By A. N. Winchell. Part I, Principles and Methods. Fourth edition, revised and enlarged. Cloth, octavo, 248 pages, illustrated. Price 21s. London: Chapman and Hall; New York: John Wiley and Sons.

Probenahme von Erzen und anderen metallhaltigen Verhüttungsmaterialen Sowie von Metallen und Legierungen mit einen Anhang. Paper covers, 108 pages. Price RM. 4. Berlin: Gesellschaft Deutscher Metallhütten- und Bergleute e. V.

Ausgewählte Methoden für Schiedsanalysen und Kontradiktorisches Arbeiten bei der Untersuchung von Erzen, Metallen und Sonstigen Hüttenprodukten. 2nd edition. Paper boards, 457 pages, illustrated. Price RM. 20. Berlin: Gesellschaft Deutscher Metallhütten- und Bergleute e. V.

Faraday and his metallurgical researches; with special reference to their bearing on the Development of Alloy Steels. By Sir Robert A. Hadfield. Cloth, octavo, 329 pages, illustrated. Price 21s. London: Chapman and Hall.

Mineral Industry of the British Empire and Foreign Countries: Statistical Summary (Production, Imports, and Exports) 1928–1930. Paper covers, 378 pages. Price 5s. 6d. London: H.M. Stationary Office.

Gold Coast Colony: Geological Survey Department Report, 1930-31. Paper folio, 17 pages. Price 2s. London: Crown Agents for the Colonies.

Mines Department Report, 1930-31. Paper folio, 20 pages. Price 2s. London: Crown Agents for the Colonies.

Nigeria: Geological Survey Report, 1930. Paper folio, 43 pages, with key maps. Price 4s. London: Crown Agents for the Colonies.

Canada Year Book, 1931. Cloth, octavo, 1148 pages, with key map. Ottawa: Dominion Bureau of Statistics.

Cleveland District, Ohio: Geology and Mineral Resources. By H. P. Cushing, F. Leverett, and F. R. Van Horn. United States Geological Survey Bulletin 818. Paper covers, 138 pages, illustrated, with maps. Price 65 cents. Washington: Superintendent of Documents.

Goodsprings Quadrangle, Nevada: Geology and Ore Deposits. By D. F. Hewett. United States Geological Survey Professional Paper 162.

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sections and reduces the ore to approximately minus 6 to minus 10 mesh, depending upon the character and moisture content of the ore, by rolls operating in closed circuit with impact screens. Fine grinding to approximately 10% plus 100-mesh is done in two stages by ball-mills operating in closed circuit with drag classifiers. A bowl classifier is placed between the two stages receiving the finished pulp of the first stage and delivering sand to the second stage and overflow pulp which is joined by the finished ground product of the second stage, both products going to flotation treatment after thickening.

The main flotation plant consists of 60 rows of single spitz mechanical-air machines, each row consisting of 8 rougher cells, 2 primary cleaner cells and 1 secondary cleaner cell. Flotation feed pulp contains between 24 and 26% of solids. Reagents used are lime, sodium aerofloat, raw cresylic acid and cyanide. The flotation concentrate, after thickening, is filtered, the final cake containing about 10% of moisture.

For the month of April, 1930, the Magna plant treated 843,800 tons of ore which averaged 0·957% of copper. The concentration ratio was 36·805 tons into 1, the recovery of total copper amounted to 89·37% and the concentrate produced contained 31·49% of copper. Concentrating costs, for a 29-day period in 1929 for the Magna and Arthur mills, when both plants were operating was $0·302 per ton.

Use of Natural Gas in Zinc Production.—Report of investigations No. 3091 of the United States Bureau of Mines contains details of a process in which methane or natural gas is used as a reducing agent for zinc. The process, which is expected to have a revolutionary effect on the production of metallic zinc from relatively low-grade ore, is the invention of Charles G. Maier, metallurgist at the Pacific experiment station, Berkeley, California. It follows three years of experimental study by the Bureau of Mines to determine if zinc-smelting costs could be reduced and high quality maintained. By his invention zinc of electrolytic purity is said to be producible with comparative economy. Calculations made at Berkeley enabled the prediction of the chemical combination of zinc oxide from the ore and of methane or natural gas at a certain temperature—less than 1,000° C. This is comparatively less than that required in other methods and is vitally effective in economy of plant construction and of operation, and there are other advantages in low maintenance costs, in minimized labour, high recovery, and quality of product.

The use of natural gas in the new process is expected to have many important effects. It is particularly suitable for continuous countercurrent operation permitting high extraction of zinc without interruption. The undesirable formation of blue dust, a mixture of 10% zinc oxide and 90% of impalpable zinc powder, and difficult to control in the older dry processes, can be practically eliminated by it. There is no expense for gas-producer equipment to convert coal to gaseous fuel. The fuel economy is high, as 12,000 cu. ft. of methane at 10 cents per thousand will reduce 1 ton of metallic zinc for which 1 ton of coal would otherwise be required. The possibilities of the new method have been proved by trial at the Rare and Precious Metals Experiment Station at Reno, Nevada.

SHORT NOTICES

Mucking.—The cost of mucking is discussed by M. J. Elsing in *Engineering and Mining World* for November.

Dredge for Deep Work.—A short description of a dredge able to work to a depth of 130 ft. below water line, constructed for Killinghall Tin, Ltd., appeared in the *Times Trade and Engineering Supplement* for November 14.

Hydraulicking. — J. E. Moran describes hydraulic operations on Otter Creek, B.C., in the British Columbian *Miner* for November.

Drive Curves.—In *Engineering and Mining World* for November, K. L. Bockman describes a method of laying out direction lines for drive curves.

Flotation.—M. Mortenson gives a new method for graphically analysing flotation test results in *Mining and Metallurgy* for November.

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Paper covers, 172 pages, illustrated, with maps. Price $1 15. Washington: Superintendent of Documents.

Los Angeles County, California: Geology of the Eastern Part of the Santa Monica Mountains. By H. W. Hoots. United States Geological Survey Professional Paper 165-C. Paper cover, pp. 84–134, illustrated, with maps. Price 75 cents. Washington: Superintendent of Documents.

Naval Petroleum Reserve No. 3, Wyoming: Significance of Geologic Conditions. By W. T. Thom, E. M. Spieker and H. Stabler. United States Geological Survey Professional Paper 163. Paper covers, 64 pages, illustrated, with maps. Price $1 25. Washington: Superintendent of Documents.

Cotton Valley Field, Louisiana: Engineering Report. By J. S. Ross. United States Bureau of Mines Technical Paper 504. Paper covers, 69 pages, illustrated. Price 30 cents. Washington: Superintendent of Documents.

Estonian Oil Shale: On the Chemistry of "Kukersite." By P. N. Kogerman. Paper covers, 85 pages, illustrated. Price 1s. 6d. University of Tartu.

Russia: The National Income of the U.S.S.R. Birmingham Bureau of Research on Russian Economic Conditions Memorandum No. 3. Paper covers, 16 pages. Subscription price to Series, 8s. 6d. Birmingham University, Russian Department.

Newfoundland, Crown Colonies, and Protectorates (Section 1): The Manufacturing Industries of the British Empire Overseas, Part V. Paper folio, 64 pages, illustrated. Price 2s. 6d. London: Erlangers Ltd.

COMPANY REPORTS

Van Ryn Gold Mines Estate.—This company was formed in 1894 and works a gold mining property in the East Rand. The report for the year ended June 30 last shows that 507,000 tons of ore was milled, the gold recovered amounting to 117,376 oz., worth £498,120. Profit from accumulated slimes brought the total revenue up to £501,824, while working costs were £450,722, the working profit being £51,102. Dividends paid during the year absorbed £25,000, equal to 5%. The ore reserves at the end of the year were estimated to be 576,664 tons, averaging 4 dwt. over a stoping width of 42 in., as compared with 765,088 tons, averaging 4 dwt. over 44 in., at the end of the previous year. During the year under review reclamation in old workings produced 250,998 tons of ore, equal to 32% of the ore mined.

Lydenburg Platinum Areas.—This company was formed in 1925 to work a platinum mine in the Lydenburg district of the Transvaal. The mill was started in 1926, but operations ceased in November, 1930. The report for the year ended June 30 last shows that during the five months it was running the plant treated 21,045 tons of ore, the recovery amounting to 5,240 oz. of platinum group metals. Working costs at 18s. 1d. per ton milled showed a reduction of 9s. 2d., when compared with the figures for the previous year. The operating profit for the year was £6,790, a balance of £6,469 being carried forward. The ore reserves at the time of closing down were estimated to be 100,900 tons, averaging 4 3 dwt.

South-West Africa Company.—Formed in 1892, this company is working the Abenab vanadium mine in South West Africa. The report for the year ended June 30 shows that sales of vanadium concentrates fell off, although working at the mine continued to be satisfactory, the output being increased. Prospecting is still being carried on in the Damaraland Concession, the company's title to this area having been extended by three years. The profit for the period under review was £40,958, the amount available for distribution being £90,324. A dividend and bonus, equal together to 7½%, absorbed £39,885 and £50,439 was carried forward.

Naraguta (Nigeria).—This company was formed in 1910 and works alluvial tin properties in Northern Nigeria. The report for the year ended March 31 last shows the output of tin concentrates to have been 357½ tons, as compared with 389 tons in the previous year. The average price realized per ton was £69 17s. 11d., as against £117 0s. 2d. in the previous year. The profit on the year's working was £4,708, a credit balance of £35,277 being carried forward.

Naraguta Korot.—Formed in 1925, this company works an alluvial tin property in Northern Nigeria. The report for 1930 shows the output to have been 187⅛ tons of tin concentrates, as compared with 198 tons in 1929. The average price realized per ton was £74 4s. 4d., and the loss for the year was £2,399. Costs have since been appreciably reduced and it is expected that the company will be able to produce its restricted output without further loss.

Filani (Nigeria).—This company was formed in 1911 to work alluvial tin property in Northern Nigeria. The report for the year 1930 shows that 55½ tons of tin concentrates were produced, as compared with 53¼ tons in the previous year. The loss on the year's working was £615, in spite of the fact that working costs were reduced to £69 18s. 3d. per ton.

Lake View and Star.—This company was formed in 1910 to work gold mines in the Kalgoorlie district of Western Australia. The report for the year ended June 30 last shows that 173,111 tons of ore, including 78,741 tons purchased from tributers, was treated for a yield of £564,676, the percentage of extraction being 93·09%. The net profit for the year amounted to £102,118, giving an available total, with the amount brought in, of £110,564. Of this amount £99,367 has been set aside for special development of Ivanhoe Horseshoe and Chaffers leases and for depreciation, leaving a balance of £11,197 to be carried forward. The positive ore reserves at the end of the year were estimated to be 756,302 tons of an average value of 37·6s. per ton, in addition to broken ore and probable ore reserves amounting to 614,200 tons. As regards the new plant it is reported that considerable progress has been made with its erection and that the central crushing plant has been completed and is working satisfactorily.

Burma Corporation.—Formed in 1919, this company works a group of silver-lead, zinc, and copper mines at Bawdwin in Upper Burma. The report for the year ended June 30 shows that the output of refined lead and silver for the year amounted to 76,520 tons and 6,512,780 oz. respectively, as compared with 79,267 tons and 7,254,780 oz. in the previous year. During the year 462,184 tons of ore was extracted, having an

average assay value of 21·9% lead, 11·4% zinc, 1·62% copper and 19·5 oz. silver per ton, as compared with 500,585 tons, averaging 21·5% lead, 11·6% zinc, 1·27% copper and 18·7 oz. silver per ton, in the previous year. In addition to the lead and silver produced, 53,395 tons of zinc concentrate, averaging 52·11% zinc, 6·14% lead and 9·63 oz. silver per ton, was shipped to Europe, and 5,272 tons of nickel speiss, 17,274 tons of high-grade copper matte, and 1,697 tons of antimonial lead recovered from the blast furnaces. The ore reserves at the end of the year were estimated to be 4,233,120 tons, averaging 25·5% lead, 15·3% zinc, 0·76% copper and 20·1 oz. silver per ton, as compared with 4,265,665 tons, averaging 25·5% lead, 15·3% zinc, 0·88% copper and 20·4 oz. silver per ton, at the end of the previous year. The net profit for the year amounted to Rs. 22,01,325, to which must be added the sum of Rs. 9,55,371 brought forward from the previous year, making an available total of Rs. 31,56,696. Rs. 25,36,067 was distributed as a dividend, leaving a balance of Rs. 6,17,629 to be carried forward.

Pahang Consolidated.—This company was formed in 1906 and works tin mining properties in the State of Pahang on the eastern side of the Malay Peninsula. The report for the year ended July 31 last shows that 174,100 tons of ore was milled for a yield of 2,799 tons of tin concentrates and that 36½ tons of alluvial tin was also recovered, bringing the total output up to 2,835½ tons, as compared with 2,698 tons in the previous year. The average price realized for the product fell from £114 per ton to £78, the profit for the year being £37,199, against £63,693 in the previous year. It reflects credit on the management of this mine that once again working costs have been markedly reduced, being 21s. 6d. per ton during the year under review, as compared with 26s. 11d. in the previous year and 28s. 5d. the year before. Development was curtailed during the year owing to the restriction of tin output.

Tekka.—Formed in 1920, this company works an alluvial tin property in the Kinta district, F.M.S. The report for the year ended March 31 last shows that 962,450 cu. yd. of ground was treated during the year for a recovery of 457 tons of tin concentrates, as compared with 540 tons from 997,600 cu. yd. in the previous year. The gross profit for the year was £16,038 and, after writing off £4,500 for depreciation, and adding the sum of £28,840 brought in, there was an available total of £40,378. Of this amount, dividends equal to 10½d. per share absorbed £15,688, leaving a balance of £24,690 to be carried forward.

Pari Tin.—This company was formed in 1922 as a reconstruction of Tronoh South, Ltd., and operates alluvial tin properties in the Chemor district, F.M.S. The report for the year ended June 30 last shows that 84,515 cu. yd. of ground was treated, 24 tons of tin concentrates being recovered, as compared with 31·1 tons in the previous year. The output realized £1,746, equal to £72·75 per ton, as compared with £104·07 per ton the year before. The year's operations were conducted at a loss of £1,299, the credit balance available being reduced to £1,488, which was carried forward. Since the close of the year, mining operations have been stopped, with the exception of a small amount of tribute work, and a caretaker has been placed in charge of the property.

Kepong Dredging.—This company was formed in 1923 and operates alluvial tin properties in the State of Selangor, F.M.S. The report for the year ended June 30 last shows that the dredge was in operation for two months only during the year owing to restriction and the low price of tin. Advantage was taken of the stoppage to alter the treatment plant. The area dredged was 1,218 acres, the total yardage treated being 122,180 and the recovery 72·99 tons of tin ore. The year's work resulted in a loss of £4,512, leaving a debit balance of £2,162 to be carried forward.

Kamra Tin.—This company was formed in 1927 and works alluvial tin property on the island of Puket, Siam. The report for the year 1930 shows that 878,650 cu. yd. was treated during the year, 301 tons of tin concentrates being recovered. Although the dredge commenced digging early in the year, severe drought restricted operations necessitating the installation of a pumping plant to pump sea-water to the paddock, a measure which has proved satisfactory. The operations for the year show a loss of £754.

Camp Bird.—This company was originally formed in 1900 to work a gold mine in Colorado, but now has other interests, including the Santa Gertrudis mine in Mexico and the Lake George mine in N.S.W. The report for the year ended June 30 last shows that the lessees of the Camp Bird mine paid £3,640 in rent and royalties during the year, all of which was absorbed in maintenance. Operations at the Santa Gertrudis mine are reviewed elsewhere in this issue. The Lake George mine was closed down during the year, the work done prior to the suspension of operations entirely solving the metallurgical difficulties outstanding and rendering the ore reserve position secure. Plans have been prepared for the construction of a plant to treat 1,000 tons per day and a bill for the connexion of the property to the railway has been passed by the N.S.W. Government. At present research is being carried out with the idea of recovering sulphur from concentrates, and the results of this work will largely influence the type of plant to be erected. The results of the Mexican Corporation are also reviewed elsewhere in this issue. The Durango Timber Co.'s profits suffered severely during the year, while those of the Creole Petroleum Corporation were also affected. The profit of Camp Bird for the year was £67,161, which has been increased by £73,286 brought in, and £100,000 transferred from reserve, giving an available total of £240,447. Of this amount, interest payments take a substantial proportion while £114,316 has been written off the value of investments, etc., a sum of £54,377 being carried forward.

Mexican Corporation.—This company was formed in 1919 and is interested in the Teziutlan copper-zinc property in Puebla and also in the Fresnillo silver mine, Zacatecas, Mexico. The report for the year ended June 30 last shows that at Fresnillo the cyanide mill treated 764,490 dry tons of oxide ore and 15,710 dry tons of Santa Ana tailings, a total of 780,200 tons, averaging 0·12 dwt. gold and 5·34 oz. silver. The bullion recovered contained 3,624 oz. of gold and 2,831,811 oz. of silver. The concentrator treated by selective flotation 251,216 dry tons of sulphide ore, averaging 0·28 dwt. gold, 9·29 oz. silver, 9·1% lead, 11·0% zinc and 0·53% copper, producing 38,350 tons of lead concentrates, 40,609 tons of zinc concentrates and 513 tons of iron concentrates. The ore reserves at the end of the period under review were estimated to be 781,531 tons of oxide ore, averaging 0·13 dwt. gold and 5·66 oz. silver per ton, together with

189,044 tons of Santa Ana tailings, containing 0·34 dwt. gold and 4·58 oz. silver per ton. At the Teziutlan mine the concentrator treated by selective flotation 65,764 dry tons of sulphide ore, averaging 0·69 dwt. gold, 3·16 oz. silver, 3·20% copper, 13·82% zinc and 1·72% lead, producing 757 tons of lead concentrate, 8,906 tons of copper concentrate and 10,932 tons of zinc concentrate. The ore reserves at this mine at the end of the year were estimated to be 159,535 tons averaging 3·0% lead, 3·2% copper, 17·5% zinc, and 3·5 oz. silver and 0·87 dwt. gold per ton. The accounts of the Mexican Corporation for the period under review show a debit balance of £10,331, from which has been deducted the credit balance of £1,744 brought in, leaving a debit of £8,587 to be carried forward.

Santa Gertrudis.—This company was formed in 1909, as a subsidiary of Camp Bird, Ltd., to operate a silver mine at Pachuca, Mexico. Work on the Santa Gertrudis property ceased in 1925 and the company now works a group of neighbouring mines. The report for the year ended June 30 last shows that during the year the mill of the Cia. Beneficiadora de Pachuca treated 475,146 dry tons of ore, having a gross value of $3,751,825 U.S. currency. Of this ore 134,962 tons were produced by the Inversiones company and 340,184 by the Dos Carlos company. The bullion recovered contained 35,291 oz. gold and 8,211,049 oz. silver. The gross profits for the year were £215,684, a decrease of £113,099 when compared with the previous year. After providing for all expenses there remained a balance of £205,091, to which must be added the sum of £39,064 brought in, giving an available total of £244,155. Dividends paid during the year absorbed £174,758, equal to 2s. 3d. per share.

Frontino Gold.—This company was formed in 1911 to work gold mining properties in Colombia. In December last the capital was increased on the amalgamation with Marmajito Mines, Ltd. The report for the year ended June 30 last covers a period of twelve months' production from Silencio mine and six months' from Marmajito. The ore milled during the year, exclusive of streamers, was 36,140 tons, yielding with slags and residue 37,130 oz. of fine gold and 25,356 oz. of fine silver. The average value of the ore treated was approximately £4 8s. 3d. per ton. The working profit for the period under review was £37,368 and, after making various allowances, the balance of undistributed profit was £23,382, of which £11,547 was distributed as a final dividend on the ordinary shares, equal to 7½%, leaving a balance of £11,853 to be carried forward. At the end of the year the ore reserves at the Silencio mine were estimated to be 81,000 tons, averaging 17·2 dwt. per ton, an increase compared with the previous year of 20,800 tons, and an improvement of 1·0 dwt. in value. This increase is due to good developments in 20 South. At the Marmajito mine the reserves were estimated to be 26,700 tons, assaying 20·3 dwt. per ton, an increase of 6,000 tons compared with the estimate at the end of December last, the value being 1·5 dwt. less.

South American Copper.—This company was formed in 1928 and works a group of copper mines in the State of Yaracuy, Venezuela. The report for the year ended March 31 last shows that production continued to be restricted to the need of the treatment plant, 10,520 tons of ore being produced, averaging 3% copper, while 7,889 tons were treated, yielding 908 tons of concentrates averaging 20% copper, which realized £4,377. Operating expenses during the year were debited to production account, the loss for the year being £24,541. Pending steps to develop available water power, a Diesel engine and generator are being installed on the property and should be available early in 1932.

Weardale Lead.—This company has worked lead mines in Weardale, County Durham, since 1883. The report for the year ended September 30 last shows that 1,421 tons of dressed lead ore and 6,577 tons of fluorspar were produced during the year, as compared with 3,785 tons and 6,895 tons respectively in the previous year. There was in addition 127 tons of lead ore from mines in the company's royalty area worked for other minerals. The accounts for the period under review show a loss of £11,020, creating a debit balance of £8,462 to be carried forward.

DIVIDENDS DECLARED

Ashanti Goldfields.—20%, less tax, payable December 10.

Broken Hill South.—1s., less tax, payable December 23.

Frontino Gold.—Pref. 1s., Ord. 1s. 6d., less tax, payable January 1.

Kampong Lanjut.—6d., less tax, payable December 16.

Kleinfontein Estates.—1s., less tax, payable December 2.

Kramat Palai.—6d., less tax, payable Dec. 14.

Kramat Tin.—6d., less tax, payable December 19.

Lonely Reef.—2s., less tax, payable January 30.

Malayan Tin.—3d., less tax, payable Dec. 17.

Pahang Consolidated.—Pref. 3½%, less tax, payable December 2.

Santa Gertrudis.—6d., less tax, payable January 21.

South Kalgurli.—1s., less tax, payable Jan. 5.

Southern Malayan Tin.—3d., less tax, payable December 17.

Taquah and Abosso.—3d., less tax, payable December 16.

Transvaal and Delagoa Bay.—3s. 6d., less tax.

Tronoh Mines.—1½d., less tax, payable Dec. 31.

Wankie Colliery.—3d., less tax, payable December 4.

West African Diamond.—1½d., less tax, payable December 18.

NEW COMPANIES REGISTERED

Rustenburg Platinum Mines.—Incorporated in the Union of South Africa September 11, 1931. Capital: £500,000 in £1 shares. Directors: J. K. Crosby, R. L. Innes, D. Christopherson, and P. C. Baerveldt. So long as Potgietersrust Platinums, Ltd., and Waterval (Rustenburg) Platinum Mining Company, Ltd., respectively hold 50% and 45% of the issued capital, they may each appoint two directors. London office: 10-11, Austin Friars, E.C. 2.

Siamese Venture.—Registered as a private company. Capital: £3,000 in £1 shares. Objects: To acquire any mines and metalliferous lands in Siam or elsewhere. Directors: W. Broadbridge, P. K. Horner. Office: 62, London Wall, E.C.