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CONTENTS

EDITORIAL

AN important contribution to the literature on flotation makes its appearance this month in the shape of a useful handbook by Mr. Philip Rabone entitled "Flotation Plant Practice," published by Mining Publications, Ltd., the proprietors of THE MINING MAGAZINE.

THE Institution of Mining Engineers has accepted the offer of Messrs. Mavor and Coulson, of Glasgow, to provide £300 for a further year for a travelling studentship, which must include Canada or the United States in the itinerary of the selected candidate.

IN an appreciation of the work of Sir Ronald Ross which appeared in these columns last month reference was made to the operations of the institute at Putney which bears his name. What this institute has achieved is already widely known, but if its work is to continue fresh financial support must be forthcoming.

A NEW mineral has been discovered among a series of crystals presented by Potgietersrust Platinums, Ltd., to the Natural History Museum at South Kensington in the course of investigation by X-rays. The mineral is a compound of platinum and palladium and it has been named braggite, in honour of Sir William Bragg.

ONCE again in the present issue we are able to refer to the potentialities of metalliferous mining in this country. The district being developed by the Halkyn tunnel and that adjoining it, the Minera area, have distinct possibilities and these are discussed by Mr. J. Norman Wynne, who, after a wide experience abroad, describes the locality where he served his studentship.

ANOTHER stage in the progress of the Lochaber Water Power Scheme—the object of which is to develop hydro-electric power for the manufacture of aluminium—was reached last month when the Laggan pressure tunnel was completed. This tunnel is three miles long and more than 15 ft. in diameter and through it the waters of Loch Laggan and the Spean River have been turned into Loch Treig.

SEVERAL appointments in the Department of Scientific and Industrial Research were announced last month. Professor Alfred Fowler and Sir Clement Hindley are to succeed Sir Alfred Ewing and Sir David Milne-Watson on the Advisory Council, Sir Harold Hartley has been appointed Chairman of the Fuel Research Board, and Mr. N. V. Sidgwick Chairman of the Chemistry Research Board.

IN the course of his second presidential address to the Institute of Fuel, given last month, Sir Hugo Hirst paid some attention to the causes of the present depression in the basic industries, agreeing with the views already expressed in the MAGAZINE, that the best experts for directing an industry are found within its own orbit and those of the scientific and technical institutions which minister to its needs.

SIR ALBERT KITSON, who has recently been in Kenya engaged in the inauguration of a geological survey, has issued an interim report on the Kakamega goldfield. From the evidence he has been able to accumulate he is of the opinion that the prospects of the field are distinctly encouraging. Exploration work at Kakamega is now being actively prosecuted and the development of deeper ground will be watched with interest.

THE work of the Imperial Institute appears likely to be considerably curtailed by lack of funds, according to the report to the Committee on Methods of Economic Co-operation submitted by the United Kingdom at the Ottawa Conference. It was stated that in 1933 it will be necessary to encroach upon investments if the institute is to pay its way, a state of affairs which appears deplorable in view of the valuable work which the institute is peculiarly fitted to carry out.

ELSEWHERE in this issue the first of four articles on lightning, by Mr. John F. Shipley, appears. In these articles the author, after dealing with some general features of lightning, will discuss the protection of power plant, life, and property, concluding with a description of the nature and causes of breakdowns of electrical plant due to lightning. It is interesting to note that a movement for the study of lightning dangers and the means for averting them is on foot in South Africa, where a committee, under the chairmanship of Dr. O. R. Randall, of the Witwatersrand University, has recently begun its inquiry into the subject.

THE customary luncheon organized by the West African Information Bureau was held in London last month, the principal guest being Major N. R. Junner, Director of the Gold Coast Geological Survey, who subsequently gave an address on "The Gold and Other Mineral Resources of the Gold Coast and Sierra Leone." Major Junner expressed the view that the examination of the favourable prospects abandoned before the war could only be profitably undertaken by well-financed companies experienced in the opening up of mining properties in the tropics. In this connexion, therefore, it is of interest to note that in the address of the Governor of the Colony at the opening of the Legislative Council in September it was stated that active exploration of certain gold-bearing areas was to be undertaken by a powerful corporation.

Pyritic Ore-Bodies

The first meeting of the 1932–33 session of the Institution of Mining and Metallurgy was held last month, the paper for discussion—"The Genesis of the Perrunal-La Zarza Pyritic Ore-Body, Spain," by Mr. Gordon Williams—having been published in the September *Bulletin*. It will no doubt be recalled that the author has been persuaded to reopen the controversial topic of the genesis of the pyritic ore-bodies of the Huelva district in Spain, a problem which has exercised the ingenuity of such well-known geological experts as Gregory, Finlayson, Collins, and others. The prospect of further arguments and, perhaps, the hope that there might even be a display of intellectual fireworks by the protagonists of the various theories of origin had attracted a good audience and the well-attended meeting augured well for an interesting session.

The mineralized region which extends from Portugal into the Spanish provinces of Huelva, Sevilla, and Cordova embraces many famous mining properties, notably those of the Rio Tinto Company. The ore-body dealt with in the present paper, however, is worked by the Tharsis Sulphur and Copper Company, of Glasgow, and the Société Française des Pyrites de Huelva, of Paris. The portion of the body worked by the English company has been developed by both open-cast and underground workings, the ore itself—a massive pyrites—being mainly exported for its sulphur content. Mr. Williams describes the structural relationships between the ore-body and the surrounding rocks and discusses current genetic hypotheses in the light of his own observations. Although somewhat lengthy extracts of the author's paper were given in the last issue of the MAGAZINE, his conclusions may be briefly outlined here. Mr. Williams finds the ore-body—and in speaking of the La Zarza body he has in mind the many similar ore-bodies of the same field—to occupy a tension fissure formed by torsional movements and is of the opinion that it has not replaced the brecciated material of a shear-zone. As for the manner in which the ore was introduced, the author concludes that the massive ore has crystallized from original pyritic fluids, the disseminated ore being due to replacement by hydrothermal solutions, the selective replacement of the porphyry being mainly due to its greater susceptibility. The pyritic fluids are considered as aqueo-igneous melts containing a high proportion of pyrites, introduced to their present site at high temperatures, the aqueous mother-liquor rejected on crystallization of the pyrites being largely responsible for the alteration of the adjacent porphyries. It is admitted by the author that his acquaintance with the other ore-bodies of the Huelva province is limited, but he would, nevertheless, apply his principles to account for their genesis also, believing the same factors to be generally operative in the field, although their effects would, of course, be controlled by particular environments. The discussion of Mr. Williams' paper was inaugurated by Professor Cullis, who found the credit it bestowed on the Geological Department at the Royal School of Mines a worthy refutation of recent reflections on its virility. Professor Cullis also recalled that the theory of dual origin for the ore was not original, having been suggested by Mr. G. W. Gray in the course of discussion on Collins' paper of 1922. In conclusion, this speaker was appreciative of the opportunity of visiting the property given to other students as well as to the author by the operating company. At this point the president intervened to read a communication from Mr. W. P. Rutherford, chairman of the company, expressing qualified acceptance of the author's views, the discussion being continued by Mr. G. W. Gray, who was disposed to be merry at the expense of the mining geologist, as well he might be with such solid ore-bodies at Rio Tinto, whereas work on a more erratic field might have made him more appreciative of their help. Other members taking part in the discussion were Messrs. Phemister, MacIntosh Bell, Vivian, Boswell, Edge, and David Williams, the remarks of the last-named being curtailed owing to exigencies of time, although his full contribution in writing should form a valuable addition to the literature on the subject.

The origin of the pyritic ore-bodies of the Huelva district is apparently still under dispute, and really one can find more cause for congratulating the author on his excellent map—ample evidence of his careful work in the field—than on his theorizing. His application of the strain ellipse, for example, tends rather to the use of mathematical illustration where nothing but common sense is needed, a way of lending weight to what is after all an open argument. It would seem that formulating theories of ore origin should, in general, be regarded more as the relaxation of the mining geologist than his actual work, which should be devoted to careful observation. How the ore came there is, after all, not of great importance, for it is unlikely that it will be removed by the same causes. In other words, discussions of genesis are often given undue prominence in the presentation of geological papers, where, of course, facts should be fairly set out. Speculation, as in the case of the present paper, rather tends to distort what would otherwise be an excellent description of a mineral occurrence.

Nigeria in 1931

The appearance of the report of Mr. Langslow Cock, Chief Inspector of Mines for Nigeria, for 1931 affords evidence of the effect of the tin restriction schemes on mining affairs in that colony. During the year there were 52 mining companies and 55 individual workers operating on tin, as compared with 83 companies and 70 individuals in the "boom" year of 1928. On the other hand, five individuals and one company were winning gold, against but one individual in 1928, while one individual and one company were mining silver-lead and one individual was producing mica. The returns from the tin companies show a total output of 9,800 tons of concentrate, a decrease of 2,101 tons on the 1930 output and 3,244 tons less than the production for 1928. The total working costs—including royalties, freights, returning charges, and London expenses—averaged £79 per ton, the average price realized being £80, leaving the small margin of £1 per ton as profit, as compared with £35 per ton for 1928. The labour employed on the mines during the year was 134 Europeans and 20,763 natives, while, in addition, there was labour-saving plant and machinery representing 6,000 h.p., against 6,700 h.p. in 1930.

The output of gold for the year was 699 oz., an increase of 439 oz. as compared with the amount won in 1930 and 635 oz. more than the 1928 production, figures which serve to show the attention now being paid to gold prospecting in the colony. As regards the silver-lead deposits, no work was done during the year at Abakaliki by the Nigerian Base Metals Corporation, Ltd., but at Zurak 2,015 tons of lead concentrates, containing 251,855 oz. of silver, were produced by the Northern Nigeria Lead Mines, Ltd. At present these concentrates have to be carried by canoe to Lokoja.

Mr. Langslow Cock makes special reference to the incidence of the restriction policy and the time of stress among the tin-producing companies. As he points out, several concessions have been granted by the Government for easing the companies' burdens, including the waiving of labour obligations on mining leases and rights, the suspension of the terms on which water rights were granted, the reduction of rents on mining leases, the introduction of "delayed" mining lease applications, and the granting of a compensating allowance of quota to those owners whose quota would otherwise be below three tons a quarter. It is pointed out, too, that the royalty payable to the Government with tin at its present price—in fact, when it is below £180 per ton—is only two per cent. of its value.

Westralian Reminiscences

The cablegram from Sydney last month announcing the death of the discoverer of Coolgardie — William Ford — must have aroused memories among those able to carry their minds back for forty years. Ford was accompanied by Arthur Bayley, whose name subsequently figured in several company promotions, which sprang up like mushrooms, and in many cases disappeared as rapidly, so that the memories may not always be of the most favourable character. Perhaps the undertaking that will be best remembered among the Coolgardie flotations was the Londonderry, on which extraordinarily rich specimens were met with at a shallow depth. To assist the promotion these were sent to England and exhibited in the City in Queen Victoria Street, the shop window being fitted with iron bars, with a stalwart policeman on guard on either side. The whole of the shares were rapidly taken up, but it was not long before those who received "letters of regret" were congratulating themselves on securing no allotment. Ford, travelling east from Southern Cross, discovered Coolgardie and Pat Hannan, travelling still further east, discovered Kalgoorlie. As in Coolgardie, ground was rapidly pegged out and scores of companies were formed and the shares offered to the public, in many cases on the strength of reports of "mining engineers" who were formerly grocers or bank clerks. Of course, all the properties possessed the celebrated Boulder lode, which led to this being depicted at the time by a local paper as a sort of octopus. Everything offered from Kalgoorlie—notwithstanding an exceedingly heavy purchase consideration for an area of unproved ground—was greedily devoured, the working capital of some £20,000—generally about a fifth of the total capitalization—invariably being lamentably insufficient. Where, however, development showed a company to possess a mine there was not much difficulty in securing the necessary capital for putting it on a paying basis. Many of the directors of Westralian undertakings in those early days must, however, have been surprised when they really found they possessed a mine. The management, too, often left something to be desired, influence counting for more than qualifications when the appointments were made, in one case the cyanide plant being put on the hill and the battery at the bottom. Luck in mining was not altogether absent at Kalgoorlie, for on one occasion, while excavating to put in a telegraph pole, a lode was intersected. Notwithstanding all drawbacks—and they were many, as is the case with most new goldfields—Kalgoorlie has given a good account of itself and is still a long way from being finished. Its early progress, as well as that of Coolgardie, was, however, largely due to the foresight of Sir John Forrest, who not only carried water several hundred miles to the goldfields, but rapidly pushed ahead with railway construction.

Travelling northwards from Kalgoorlie, many smaller districts were opened up, two of the chief being Broad Arrow and White Feather, the Reward mine, in the latter district, featuring for some time in the dividend-paying list, and still further north was the Menzies district, named after its discoverer, where the leading property was the Lady Shenton, also a dividend payer for many years. Continuing northwards, Mount Margaret and Mount Leonora were reached and on these goldfields the mine of chief importance proved to be the Sons of Gwalia, with the management of which H. C. Hoover —now President of the United States—was for some time identified. The successful development of the Sons of Gwalia led to the pegging out of surrounding areas and the formation of a number of Gwalia undertakings, whose careers were of short duration.

The East Murchison and Murchison goldfields—still going north—will be well remembered as being responsible for the flotation of several mining properties, good, bad, and indifferent, the United mine on the former belonging to the first-named category and paying dividends for some time, thanks to its capable management. Peak Hill is the northernmost point to which reference need be made. Here only one property — the Peak Hill Goldfield — was developed, but its basin-like deposit was soon worked out, although during its short career it was visited by the Governor of the State, Peak Hill gold plates being used at the luncheon. Many interesting incidents could be related with regard to Westralian gold discoveries, which have extended from Norseman to Kimberley and from Southern Cross to Hampton Plains, and this brief résumé of reminiscences can be concluded with that of the official on one of the northern fields who in picking up a stone to throw at a bird noticed it contained gold. In his excitement he simply cabled the Minister of Mines: "I picked up a stone to throw at a crow," to which the Minister replied: "What happened to the crow?"

REVIEW OF MINING

Introduction.—The most important event of the past month has been the successful issue of the Government's £300,000,000 3% Conversion Loan, by which the obligations maturing at the end of the year will be met. The metal market shows some signs of improvement, zinc, perhaps, being in the strongest position.

Transvaal.—The output of gold on the Rand for October was 926,686 oz. and in outside districts 48,279 oz., making a total of 974,965 oz., as compared with 961,501 oz. in September. The number of natives employed in the gold mines at the end of the month totalled 216,298, as compared with 216,398 at the end of September.

The publication of the quarterly reports of the Rand mines has disclosed several interesting points. At the Sub Nigel, for instance, it is stated that in the 33rd level—the lowest reef development in the mine—encouraging results have been obtained, 120 ft. in the 33 drive east averaging 213·3 dwt. over 6 in., while 355 ft. in the drive east from the 31·5 winze averaged 145·1 dwt. over 4·9 in. The City Deep announces that negotiations have been completed for the acquisition of approximately 159 claims on the dip of No. 1 shaft, which will straighten out the southern boundary. The Rose Deep announces that arrangements have been made to tribute from the Witwatersrand Gold Mining Co., Ltd., an area of approximately six partially worked-out claims. A pressure burst in the No. 1 shaft of this company adversely affected the September output.

Shareholders of Daggafontein Mines, Ltd., were informed last month that the directors had accepted an offer from the Anglo American Corporation of South Africa, Ltd., to subscribe for 23,199 of the reserve shares at a price of 45s. (South African currency) per share, with the right to subscribe for a further 23,000 shares at the same price until the end of the year, the funds thus available to be used for capital purposes. The report for the three months ended September 30 stated that dewatering of No. 2 shaft had proceeded far enough to recover the station and that the main pumping station was being cut preparatory to the installation of permanent pumping plant.

Further results of the drilling campaign on the No. 2 South East haulage at West Springs were made available last month. It was stated that a bore-hole at the haulage face had intersected reef 202 ft. below, assays showing 6 dwt. over 44 in. No further drilling in the area is contemplated and some months must elapse before the newly-discovered ground is exposed in development work.

Development in the Apex section of the New Kleinfontein company's property is now beginning to show more favourable results. New shoots encountered in work on the 14th level drive east reveal good values and work is being pushed forward as rapidly as possible in order to prove continuity.

It was announced last month that the option held by New Consolidated Gold Fields from Western Areas, Ltd., over the mineral and certain other rights in 67 square miles of land in the Far West Rand had been exercised. A company will be formed, it is stated, to undertake the development of the newly-acquired area.

A circular to shareholders of the Meyer and Charlton company, issued this month, stated that the necessary resolutions having been confirmed, the company was placed in voluntary liquidation on October 31 last.

The accounts of Afrikander Proprietary Gold Mines, Ltd., for the year to June 30 last show the royalty paid by the tributing company for the milling of ore to have been £1,321, the surplus cash at the end of the year amounting to £867.

It was announced last month that the consideration of any dividend payment by the Union Corporation would be postponed, as last year, until after the close of the financial year.

The report of Witbank Colliery, Ltd., for the year to August 31 last shows a profit of £40,872, making with the unappropriated balance brought in an available total of £121,616. Dividends equal to 6¼% absorbed £21,534 and, after making allowances for taxation, debenture redemption, and other items, there remained a balance of £79,882 to be carried forward. Coal dispatched from the property during the year totalled 691,767 tons, a decrease of 68,903 tons as compared with the previous year.

Cape Colony.—The accounts of the Namaqua Copper Company for 1931 show a loss of £18,220, increasing the debit balance brought in to £37,972. The output of fine copper amounted to 574 tons, of which 551 tons was realized during the year. All mining operations in South Africa ceased in June, 1931.

Diamonds. — The New Jagersfontein Mining and Exploration Co., Ltd., for the year ended March 31 last suffered a loss of £45,822, which reduces the credit balance brought in to £1,105. During the year a total of 602,907 loads of ground was hauled, while 288,193 loads was washed, the diamonds recovered amounting to 50,764½ carats, worth £93,809. The washing and pulsator plants at the mine were closed down in July, 1931, while all underground work, except pumping and maintenance, was stopped in January last, when, in order to avoid causing hardship to the white labour, the pulsator plant was restarted to treat accumulated tailings. This programme was continued up to the end of the year under review.

Southern Rhodesia.—The output of gold from Southern Rhodesia during September was 50,198 oz., as compared with 49,254 oz. for the previous month and 42,846 oz. for September, 1931. Other outputs for September last were: Silver, 7,677 oz.; coal, 35,106 tons; chrome ore, 1,037 tons; asbestos, 1,195 tons; mica, 2 tons; tin, 1 ton; tungsten ore, 8 tons; magnesite, 15 tons.

The report of the Wanderer Consolidated Gold Mines, Ltd., for the year ended June 30 last shows that 182,700 tons of ore was treated, from which 41,593 oz. of gold was recovered, worth, including premium, £222,631. The working profit was £66,317, leaving, after deducting tax and general expenses, a net profit of £60,155, which was carried forward. The ore reserves at the end of the year were estimated to be 225,000 tons, averaging 5·0 dwt. in value, while in addition there were held to be 206,000 tons of "indicated" ore.

Shareholders of Cam and Motor were advised of a rich strike in the Motor mine last month, assays in No. 1 winze in the No. 25 level at 145 ft. showing 35 oz. of gold per ton, while at 150 ft. values were stated to be 80 oz. per ton.

At the meeting of the Sherwood Starr company, held in Salisbury last month, the chairman stressed the importance of the large increase in the ore reserves and indicated that the plant extension would soon be completed. A cross-cut from No. 2 shaft on the 14th level was stated to have passed the schist ore-body, which averaged 32s. for a width of 9 ft.

The accounts of Gold Fields Rhodesian Development for the year to May 31 last show a realized loss of £137,483, which increases the total debit balance to £216,828. It is stated that the major part of the loss is due to the realization of the company's holding in Turner and Newall.

During the year to August 31 last the Wankie Colliery Company made a profit of £79,461, as compared with £139,823 in the previous year. After adding the sum of £17,511 brought in and allowing for taxation, the sum available was £62,337, of which £49,778 was distributed as dividend, equal to 5%. The output for the year was 547,647 tons, while coal sales totalled 433,624 tons and coke sales 33,760 tons.

Gold Coast.—The report of Appollonia Gold Fields for the 18 months to September 30 last shows that as a result of capital reorganization it has been possible to write off £66,124 from property development and other expenditure.

A circular to shareholders of Bibiani (1927), Ltd., was issued last month, giving details of developments during the quarter to September 30 last. It is stated that the erection of the power and treatment plant is proceeding satisfactorily.

Australia.—The resumption of dividend payments has been announced by the Broken Hill Proprietary Company, a half-yearly distribution of 1s. per share (Australian currency) being declared.

Preliminary figures issued by the Lake View and Star Company show a net profit for the year to June 30 last of £284,000, against £102,118 in the previous year. The company has just declared an interim dividend of 12½%, the first distribution since 1921.

Shareholders of the Great Boulder Proprietary have been informed that the new compressor plant is now completed and is said to be running well. A dividend of 3d. per share is announced.

The report of the London, Australian, and General Exploration Co., Ltd., for the year ended July 31 last shows a loss of £864, which, deducted from the balance brought in, leaves a credit balance of £346. At the annual meeting held last month it was stated that the company, in conjunction with the Sons of Gwalia and other undertakings, had sent an expedition to the Tanami goldfield in Central Australia.

New Guinea.—It was announced last month that the second dredge of the Bulolo company started work on October 25 and that it was expected to be clear of its pit and down to bedrock by the beginning of the present month.

Burma.—The report of the Kafue Copper Development Co., Ltd., for the year to June 30 last contains further details of the Mwedaw gold area in northern Burma, in which the company has taken an interest.

It is the intention of the board to carry out a two years' programme of development on the property.

The accounts of the Tavoy Tin Dredging Corporation, Ltd., for 1931 show a net loss of £33,541, a debit balance of £33,062 being carried forward. The year's output of concentrates, amounting to 739 tons, was sold at an average price of £116 per ton of metal, yielding a working profit of £1,399.

The accounts of Mawchi Mines, Ltd., for 1931 show a loss of £7,957. Of this amount £2,312 was written off under the capital reduction scheme, leaving a debit balance of £5,644 to be carried forward. During the year 61,165 tons of ore was milled, 2,939 tons of mixed concentrates being recovered. As practically no development was undertaken during the year the ore reserves were considerably depleted, falling to 86,989 tons averaging 4·46% combined tin and wolfram. During the current year development has kept pace with the mining, the reserves at June 30 last being estimated at 87,220 tons, of which 68,962 tons were regarded as fully proved.

Malaya.—During the year to March 31 last Tekka, Ltd., made a profit of £6,644, which, added to the balance of £24,690 brought in, gave an available total of £31,334. Of this amount £8,964 was distributed as dividends, equal to 6d. per share, leaving £22,370 to be carried forward. The year's output totalled 341 tons of concentrates, worth £24,459. The effect of restriction was to reduce the yardage treated from 962,450 to 835,100.

Shareholders of Malayan Tinfields, Ltd., were informed last month of an offer to acquire the company's shares put forward by the London Tin Corporation. The offer was conditional on holders of not less than 75% of the issued capital of Malayan Tinfields accepting.

Siam.—The accounts of Kamra Tin Dredging for 1931 show a loss of £1,891, increasing the debit balance carried forward to £2,645. During the year 566 tons of concentrates was recovered from the treatment of 2,030,000 cu. yd. of ground, equivalent to 0·625 lb. per cu. yd., at a working cost of 3·961d. per cu. yd.

Canada.—A circular to shareholders of the Mining Corporation of Canada, issued last month stated that the corporation had decided to exercise its option over 500,000 unissued shares of the Ashley Gold Mining Corporation, Ltd., and to offer one Ashley share to holders of five Mining Corporation shares at a rate of 60 cents per share.

Panama.—It was announced this month that all the assets of the Panama Corporation have now been transferred to the Canadian company, whose rights have been recognized by the Government of Panama.

Spain.—The accounts of the Tigon Mining and Finance Corporation for the year to March 31 last show a loss of £8,695, increasing the debit balance brought in to £15,937. Production of sulphur at the Spanish property is now at the rate of 2,400 tons per annum, all of which finds a ready market. In Chile the accumulated stocks were disposed of and production at the rate of 10,000 tons per annum was resumed in June last.

It was announced last month that no interim distribution on the ordinary shares of the Rio Tinto company would be made this year.

Italy.—During 1931 the Libiola Copper Mining Company suffered a loss of £4,377, increasing the debit balance brought in to £8,892. The production for the year was 7,648 tons of pyrites and 776 tons of copper ore, the reserves at the end of the year being estimated at 20,670 tons of pyrites and 9,160 tons of copper ore. In view of the difficulty which is being experienced in financing work at the mine and development at Castagna, it is feared that it may become necessary to cease operations.

British Tin Investment Corporation.—At a meeting of the British Tin Investment Corporation held last month a proposal to increase the capital from £1,250,000 to £1,600,000 by the creation of 700,000 new ordinary 10s. shares was approved.

Imperial Smelting Corporation.—The report of the Imperial Smelting Corporation for the year to June 30 last showed a profit of £137,472, which, added to the sum brought in, gave an available total of £151,876. Of this amount preference dividends absorbed £134,538, leaving £17,338 to be carried forward. During the year the company acquired an important interest in Fricker's Metal and Chemical Co., Ltd.

Trinidad Leaseholds.—The accounts of Trinidad Leaseholds, Ltd., for the year ended June 30 last show a net profit of £272,719, giving, with the sum brought in, an available total of £302,870. Of this amount £163,945 was distributed as dividends equal to 12½%, and, after making allowances for income tax and other items, there remained a balance of £63,999 to be carried forward.

THE MINERA AND WEST DENBIGHSHIRE LEAD AND ZINC MINING DISTRICT

By J. NORMAN WYNNE, M.I.M.M., F.G.S.

A review of the history and some views of the potentialities of what was once a famous mining district in North Wales.

INTRODUCTION.—The driving of the Halkyn district drainage tunnel has directed attention to the lead and blende mines of Flintshire and the future development of the amalgamated properties made possible by this undertaking will be followed with interest. The object of the following article is to place on record information relating to the once-prosperous lead and zinc mining district that immediately adjoins the Halkyn district, now in process of being systematically unwatered, and which extends south-eastward to its limit at that point where it meets the Lower Coal Measures of the North Wales coalfield, in the neighbourhood of Wrexham. The lead-zinc veins under discussion occur in the Carboniferous Limestones and Cefn-y-fedw Sandstones Series, which extend from Minera, through the Halkyn district, and thence to the western limit—marked by the Talargoch lead mines at Dyserth—close to Rhyl on the coast.

In tabulating information relating to old properties the difficulty confronting the writer is correctly to separate the wheat of fact from the chaff of fancy. In order to do so it is necessary to discard much local lore handed down through many years, which, while often founded on fact, is liable to become embellished and exaggerated in the process. At the same time it must be borne in mind that no official records exist of many ancient mines that were closed for reasons that have no relation to geological conditions. Water, petty jealousy between interested parties, financial difficulties, and other factors have all played their part in stultifying the advantageous working of potentially rich deposits. For example, the Park mines mentioned herein were closed simply because every ounce of coal had to be transported in farm carts for at least six miles over a mountain track, which, in places, assumes a gradient of one in seven. Similarly, all lead concentrates were conveyed to the mineral line in the valley below from the top of the Minera mountain.

The writer has taken much care accurately to correlate the information contained herein, and gratefully acknowledges his indebtedness to the Geological Survey, certain Royalty Agents, Mr. G. F. Wynne (who for over fifty years was closely identified with the United Minera Mining Co., Ltd.), and others, who have kindly placed all available data at his disposal.

HISTORICAL.—That lead mining was well understood in pre-Roman times is evidenced by the pigs of lead in the Grosvenor Museum at Chester. These bear the inscription on top and side :—

IMP. VESP. V. T. IMP. III. COS.
DECEANGI.

This inscription may be translated :—(This pig was cast while) Vespasian was Consul for the fifth time and Titus for the third time. (Lead from the mines) of the Deceangi.

This dates the year of casting as A.D. 74. These pigs are 24 in. long by 6 in. wide by 4 in. thick and weigh 179 lb. It is considered that they were paid as tribute by a tribe which lived in Flintshire and Denbighshire, but it is not certain whether this tribe was called "CEANGI" or "DECEANGI" or "DECEANGLI." There is, however, a district in Flintshire called "TEGEINGL," where lead is found.

Pieces of lead piping, 4 in. diameter, with a countersunk inscription on a raised panel 48 in. long, were dug up in Chester in 1899. The inscription reads :—

(This lead piping) was made when Vespasian and Titus were Consuls for the ninth and seventh times respectively, and when Cn. Julius Agricola was Governor of Britain.

The date indicated is A.D. 79.[1]

From pre-Roman until recent times lead and zinc ores have been worked more or less continuously in the Minera and contiguous north-westerly area extending to the Llanarmon and Erryrys districts and, scattered over these four miles of country, are numerous old shafts, trenches, and other evidences of mining operations.

The Romans well understood the use of calamine in the manufacture of brass and the Saxons used lead sheet extensively in their ecclesiastical buildings. The Welsh

[1] Figs. 1 and 2, showing pig lead and piping, are reproduced by the courtesy of the Chester and North Wales Archæological Society.

FIG. 1.—ROMAN PIG LEAD.

historian Pennant (1773) recorded interesting data concerning the lead mining industry from pre-Roman times, including the discovery of Roman coins in the workings of the Talargoch mines, and of smelting operations carried on at the place called, in Welsh, "The place of the fiery furnace." It is recorded that after the Norman Conquest the Crown reserved to itself all rights over the lead deposits of Denbighshire and Flintshire, while, during the reign of Edward I, churches, including the Abbey of Basingwerk, received considerable tithes from the mines.

In 1563 Queen Elizabeth interested herself in the lead mines and in order to wrest the control from "foreigners," who monopolized the rich workings, she granted the exclusive right to work these ore-bodies to a group styled the Society of Mines Royal. During this reign a Royal Mint was established in North Wales and the coinage carried the Prince of Wales's feathers over the royal arms. Sir Hugh Middleton appears to have been the mining magnate about this time, and the amount of silver extracted from his mines led to a state of affairs which seems strangely familiar to us in these days, for over-production caused one Thomas Bushell to petition the Crown for the right to set up yet another mint at Aberystwyth, the petitioner declaring that "Sir Hugh Middleton was undone, and thousands had thus been kept from venturing on those hopeful mountains."

Sir Richard Gwynne received from James I a grant over the lead mines of Rhuddlan on the payment annually of £3 6s. 8d., which must have seemed an attractive proposition, even in those days. During the reign of Charles I Sir Richard Grosvenor was also interested in the lead-mining industry and the name of Grosvenor has been prominently associated with Denbighshire and Flintshire mining from that time to the present day. Indeed, the Duke of Westminster and Sir Watkin Wynn are to-day the principal owners of the mineral rights in both mining districts.

The records of the Minera mines show that they were being worked on a fairly extensive scale by a number of separate companies in 1766, while from the mines of nearby Llanarmon district an enormous tonnage of both lead and zinc was won. A total of nearly five million pounds worth of ore was yielded by the Minera mines and of this total over three and a half million sterling was

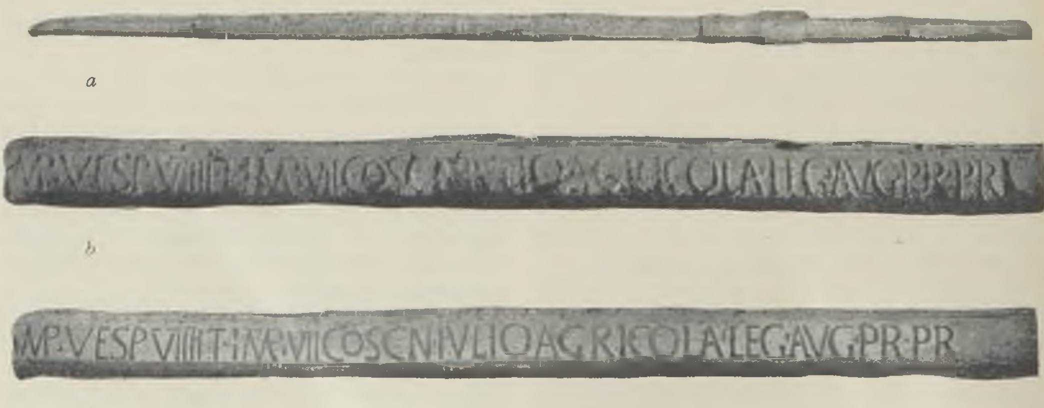


FIG. 2.—ROMAN LEAD WATER PIPE FOUND AT CHESTER. (*a*) The whole length. (*b*) Inscribed fragment as found. (*c*) Inscribed fragment with letters coloured.

realized during the years 1846–1915. During one quarter of the year 1810 the Duke of Westminster received in royalties no less than £3,800. The ore won from one particular bunch of galena realized £500,000 and it is officially recorded that from it in one month four men won 111 tons at a cost of eleven shillings and twopence a ton.[1]

The greatest width of ore exposed in the Minera workings was 9 ft. of solid galena, which was sent direct to the smelters without treatment. The greatest output of zinc-blende for one month was 700 tons. The Report Book of the Minera Mining Company (formed in 1845 by the amalgamation of 11 separate leases) shows that for over 50 years the annual dividend distributed averaged over 50%, the distribution in 1864 amounting to 160%. Prior to the amalgamation of the rival interests seven Cornish pumps were employed by the various companies to contend with the influx of water. The lot of the mine managers must then have been similar to the policeman's, for it is stated that when any individual company became too prosperous the jealous rivals promptly stopped pumping and so drowned out their lucky neighbour !

It is of interest to London mining men to note that the consolidation and operation of these combined leases was one of the very first ventures of Messrs. John Taylor & Sons and the era of prosperity which followed testifies to their organizing ability.

The bugbear of Minera—as of Halkyn—has always been the pumping problem. Rich runs of ore inevitably bottomed in water with which the seven Cornish pumps were unable to cope adequately. After disastrous experiences it was decided radically to attack the water by driving a deep drainage level from a point at 504 ft. O.D. and 360 ft. below the surface of the mines. This struck the North vein, and was then carried along the course of the lode for a considerable distance westward, and attained its object by carrying off nine-tenths of the influx. During the driving of the adit several splendid bunches of ore were met with and the discovery of these brought the mines to a highly prosperous condition. In 1862 another drainage level was driven at a higher elevation to unwater the neighbouring Park Mines.

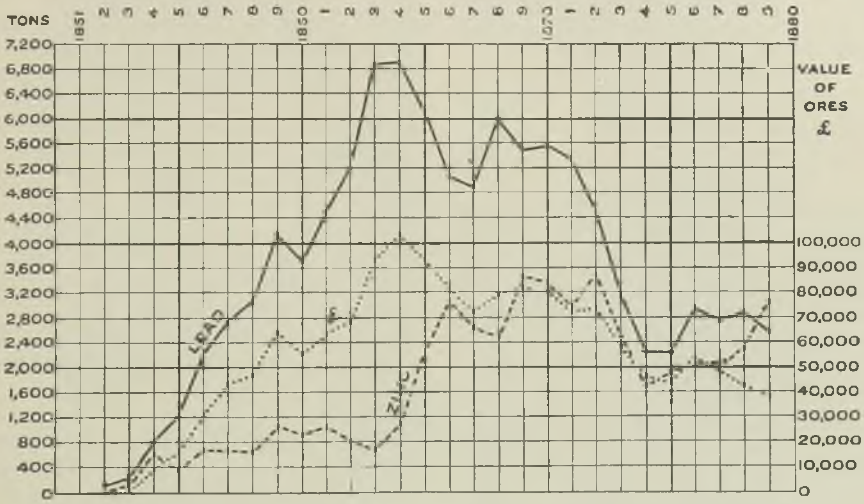


FIG. 3.[2]—CURVES SHOWING OUTPUT AND VALUE FROM THE MINERA MINES.

An extract from the *Mining and Smelting Magazine* (Vol. 2, 1862) states :—

> The lead mining in the Minera district continues to be prosecuted with vigour and success. Minera, as will be seen by our Lead Ore Sales, is now yielding 600 tons of ore per month. Adjoining this, on the south, is the Park Mine, in the hands of a rich local company. The vein, which is parallel to that of Minera, has yielded *above the water level*[1] and on a small scale of working, 18,000 tons of lead ore, which have left a profit of £162,000.

[1] The italics are mine.—J. N. W.

[1] "The late Duke of Westminster's agent is reported to have stated that about three million pounds' worth of ore had been got from the Pant Lode and Bog Mines," in the Llanarmon District (Mem. Geol. Surv., Vol. xix).

[2] Figs. 3, 4, 5, and 6 are reproduced by courtesy of the Geological Survey and with the permission of the Controller of H.M. Stationery Office.

As the price of lead ore and blende are quoted for the month of October in that journal at £12 12s., and £2 12s., and of pig lead and spelter cake at £20 5s. and £23 10s. respectively, an idea may be gained as to the working costs.

The Report Book of the Minera Mining Company shows that during the year 1863–4 the peak of production was reached with a total of 6,800 tons of galena and 1,179 tons of blende, realizing £103,293, and resulting in a profit of £64,000. In the year 1909 the pumping charges amounted to over £600 each month, chiefly owing to the high costs of the Cornish pumps and, as the price of lead and zinc were then phenomenally low, the finances of the company made it impossible to carry on operations at depth. At this time the following Cornish pumping engines were holding the water successfully at an approximate depth of 1,300 ft. :—

(1)	Taylor's	shaft, one 80 in. ;	lift 15 in.
(2)	Meadow	,, ,, 60 ,,	,, 11 ,,
(3)	New Minera	,, ,, 36 ,,	,, 8 ,,

It was decided to stop further pumping and to remove certain rich ore lying below the drainage level while the water was rising and also any ore remaining above the ultimate water level. After the final stoppage of the pumps it took two years for the workings to fill to adit level (490 ft. A.S.L.). The outfall of water during the month of April from the Minera Deep Day level averages about 2,750 gals. per min. ; during the summer this amount diminishes considerably.

Such was the state of affairs in 1915, when the United Minera Lead Mining Co., Ltd., went into voluntary liquidation. To-day the main transmission lines of the North Wales Power Company run the entire length of this once highly-productive area, carrying 50,000 h.p. at 66,000 volts. During the time spent in investigating this potentially rich district the writer has thought how different the now deserted mines might have looked had this adequate supply of cheap power but been available when the permanent overhead cost for pumping alone amounted to £600 a month. A modern high-efficiency pump in the Meadow shaft would have met the demand.

These mines still contain considerable ore reserves, and it is stated that in the very early days zinc ores were unsaleable and were not even hoisted to surface when found. The quality of Minera blende was renowned, containing as it did as high as 61·5% Zn. The assay books of the company show smelter returns of 59% and even 60% Zn., and this was from the ordinary run of mine ore and not from "picked" ore. A mineral line (G.W.R.) runs the full length of the property and connects with the main line. The calc-spar gravel dumps of Minera are now being marketed for use in concrete work, roads, granolithic stone, etc.

Park Mines.—The Geological Survey Sheet (No. 121, Solid.) shows no less than 18 lead-zinc veins lying to the south of, and parallel with, the two main veins and two subsidiary veins which constituted the United Minera Mines, and the Ordnance Sheets (6 in.) show numerous old shafts sunk on some of these. The writer has, however, failed to find any reliable record of operations thereon other than those undertaken on the two mine setts lying immediately south-west of the Minera group and, as stated in the above extract from the *Mining and Smelting Magazine*, about half-a-mile distant. These setts were known as Park and Lower Park mines, and the sett lying still further again to the south-west styled Pool Park and South Minera. The surface of these veins lies on the Esclusham mountain at an elevation some 500 ft. higher than those of Minera. One of the 18 veins mentioned—the Ragman—runs caunter to the lodes of both the Minera and Park groups.

Records of workings on the Park, Pool Park, and South Minera are scanty, but it is stated that considerable royalties were paid to the Duke of Westminster from the first-named property. The Pool Park mine yielded 1,500 tons of galena during the years 1861–1869. Other small mines in this neighbourhood are known to have produced a few hundred tons for several years. As in the case of Minera, water was here one of the main difficulties and, as mentioned in the introduction, the enormous difficulty and cost of transporting coal and other materials to the mines situated at an elevation of 1,250 ft. A.S.L. militated against profitable operations. In order to unwater this group, an adit was commenced in 1862 from a point near the centre of the Minera property at approx. 740 ft. O.D. Of this drainage tunnel the manager of the Minera Mines, Mr. George Darlington—who was also the inventor of the first valveless rock-drill—wrote in a paper to the *Mining and Smelting Magazine* (1862) :—

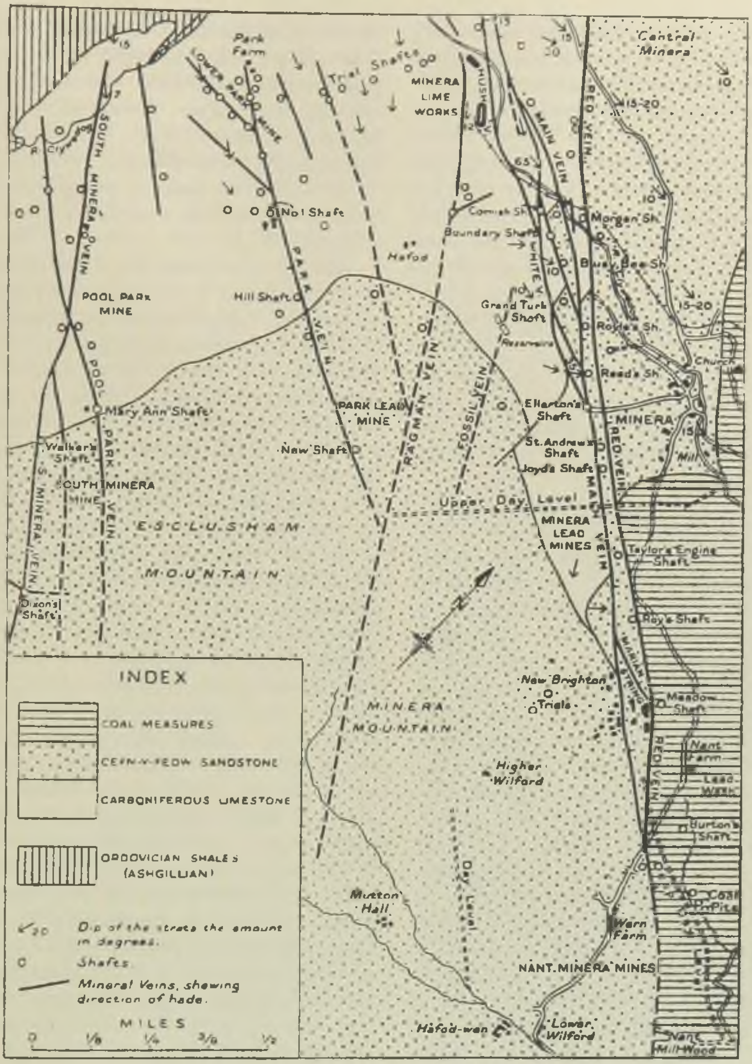


Fig. 4.—Geological Map of the Minera District.

The Park mine has been wrought through an extended period and with much success; latterly, however, the workings, though comparatively shallow, have been inundated with water, which has frustrated all recent efforts at sinking the mine deeper, or working to a profit the orey ground already discovered.

In the same year the *Mining and Smelting Magazine* reported :—

Work has been prosecuted on a small scale under the water level, below which a splendid course of ore of great length has gone down . . . It has been arranged to continue the driving of the Minera Shallow Day Level, which will come in 230 yards deep in the Park mine at the upper or Eastern Shaft. When this is accomplished the Park will, beyond all doubt, make a splendid mine; it is only a question of time and capital.

The adit referred to was to be extended about 900 ft. further at a contract price of £2,106, "this amount to include materials" —roughly £2 per lineal foot. The present outfall from the Park Adit varies from about 600 to 6000 gallons per minute after a severe storm.

On the Park veins three shafts were sunk : Western shaft, Middle shaft, and Eastern shaft, to which the drainage level was driven. No plans of these workings were, apparently, deposited at the Home Office, nor was the writer able to ascertain details relating to the "splendid course of ore of great length," which was stated to lie below the water level, except that it occurred in a massive flat of rich galena. It is recorded that the Park mine yielded 335 tons of galena and 610 tons of blende during the years 1882–1885, after which the mines ceased to operate. The late underground manager of the Minera mines informed the writer — then serving his studentship in these mines—that he and the head timberman had made their way along the Park drainage tunnel as far as the Park Mines and there found that one shaft has been sunk on 18 in. of solid galena which persisted below the adit level, below which, naturally, it was not possible to follow it. During the last month the head timberman referred to corroborated this statement and declared that the ore—polished by the swift-running water—might be seen under foot.

Space does not permit of more than the mention of the numerous workings which lie to the south-west of the South Minera and Pool Park setts, but the accompanying sketch map (Fig. 4, reproduced here by permission of the Geological Survey) makes it clear that below the surface of the Esclusham mountain lies a lode system which has never been fully explored. It would seem incomprehensible that no attempt was ever made to explore the possibilities of this obviously mineralized region by means of a cross-cut from the Minera mines at a point near the Meadow shaft. Such a cross-cut would cheaply and definitely have proved the indicated extensions of the Park series, Ragman Vein, and possibly others which do not appear to outcrop, lying to the eastward of any known workings. In asking the question : Why was this region never proved by the cross - cut so obviously indicated ? it must, however, be borne in mind that the Minera Mining Company were fully satisfied with their own rich deposits, that the driving of a cross-cut a mile long by hand labour was a formidable undertaking, and that rivalry and jealousy were rife, and even the miners resented trespass upon their particular ground. The Minera Company would naturally not stand in the way of the driving of the Park Shallow Level, as this drained considerable surface water and thus relieved the pumping at Minera Mines.

The lead and blende of the Minera district occurred in " flats," rakes," " pipes," and also in lenticular masses. Under these conditions remarkably massive deposits were encountered and the enormous cavern-like workings in Maes-y-ffynon mine (at the north-western end of the Minera sett) and Llyn-dhu bear witness to the truth of statements regarding the wealth extracted therefrom. The average width of the Minera veins was 6 ft., but the veins swelled to over 30 ft. in places. The silver content of the Minera galena averaged about 4 oz. per ton, which is less than that of Halkyn district.

Among the minerals recovered from the Minera district veins were galena and cerussite, calamine and blende, sulphate of lead, various iron ores, and copper pyrites. Barytes was never identified in the Minera workings, and fluorspar was so rare as to be regarded as a curiosity. It was held by miners that carbonate of zinc, and also the occurrence of pulverulent quartz as fine as table salt, was an infallible indication of richness at lower depths.

So far, only the main Minera veins and those lying parallel have been here briefly reviewed. To the north and west of the Minera sett are a number of old workings which mark the mines known as The Twelve Apostles, Cae Pant, Eisteddfod, Hush, Maes Maelor, etc., all of which appear to have met with some degree of success. These lie on the south side of the Bala fault, and close to it. The Twelve Apostles was named after the twelve adventurers who are reputed each to have won £1,000 in one month from their sett. Several of the miners—who hitherto had not known the taste of white bread—attended chapel clad in frock coats and silk hats, apparently as a special mark of their gratitude for this sudden affluence. Beyond these interesting sartorial details the writer failed to discover any reliable data regarding the mines now distinguishable only by the dumps.

Still on the south side of the Bala fault, but north-east of the Minera property, a group of veins crossed by three cross-courses were worked in the Cefn-y-fedw Sandstone near to Bwlch-gwyn. A number of old shafts on other veins lie on the south side of the Nant-y-ffrith valley. According to the Geological Survey Memoir the " Bwlch-gwyn mine yielded 30 tons of ore in 1850, and up to 1857, when the mine was closed, had produced 1,741 tons of galena."

On the north side of the Bala fault no workings are evident until the region of Bod Idris is reached (about two miles) except the " Old Lead Mine " shown on the Ordnance Sheet, sunk in Cefn-y-fedw Sandstone on the Llandegla moor. This may have been sunk on the supposed continuation of the Maes-y-pwll lode, worked further north-west, or, as it is situated on almost an exactly straight line drawn in extension of the strike of the Minera veins, it may have been sunk by someone who did not realize that the Bala-Llanelidan fault is older than the mineralized fault-fissures, and that tectonic conditions on the north side of this master-fault differ from those on the south side.

The Maes-y-pwll lode, according to tradition, produced considerable quantities of galena in ancient times and it is natural that an attempt should have been made to locate the extension of the rich vein. Although indications of galena have been noted in the spoil dump of the "Old Lead Mine," no lode is noticeable on the heather-covered moorland. Local inhabitants, however, assured the writer that lead was actually won from this shaft. The Bod Idris fault underlies north, as do the Minera lodes, and the mine of this name yielded 70 tons of lead ore between 1876 and 1880. The workings on the Alltgymbyd and Greigiog-isaf fault-veins, which lie to the south of the Maes-y-pwll lode, all appear to have been successful as far as they went.

The lodes just mentioned lie in the Llanarmon district and within one and a half miles of the once famous Bog Mines, which, it is understood, will mark the end of the Halkyn drainage tunnel. The whole of this district is riddled with old shafts, trenches, and other evidences of extensive mining operations. Thus, within the district briefly reviewed extending for five and a half miles from the extreme south-east end of the Minera lodes to the Llanarmon and Yale Districts, are two properties which have yielded lead and zinc ores to the value of over eight millions sterling ; in addition to the very considerable contributions of the Park, Greigiog, and other mines mentioned.

Geological.—It is not possible within the scope of an article of this length to give more than a general account of the main geological features of the district under review and for more detailed information the reader is referred to the "Special Report on the Mineral Resources of Great Britain : Lead and Zinc Ores in the Carboniferous Rocks," Vol. XIX (Dr. Bernard Smith), and also the Department of Scientific and Industrial Research Memoir : The Geology of the country around Wrexham, Part I.

Referring to the sketch map (Fig. 5, also reproduced by the courtesy of the Geological Survey), it will be noted that the Cefn-y-fedw Sandstones (so-called Millstone Grit) Series overlies the Carboniferous Limestone Series (Sandy limestone, Coral beds, Upper Grey Limestone, White Limestone, Lower Grey and Brown Limestone, and Basement Beds). Below these lie Silurian and Ordovician shales. At the south-eastern limit of the Minera property the Lower Coal

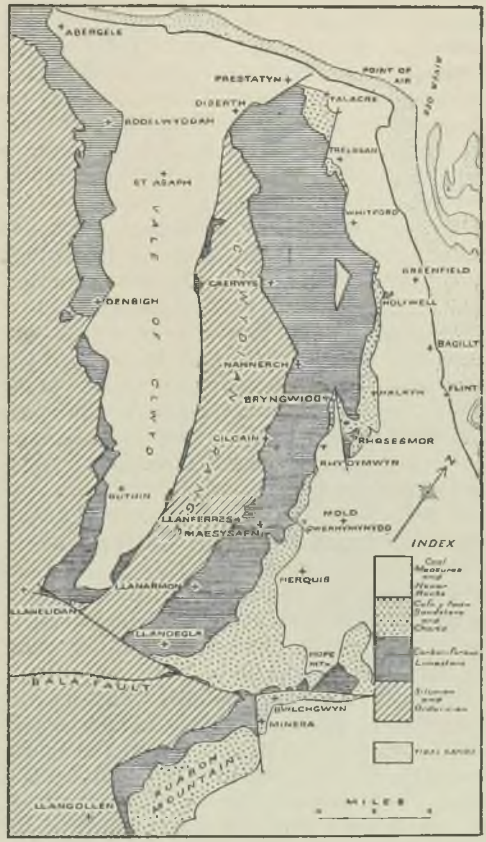


Fig. 5.—Geological Sketch Map of the Country from Abergele to Llangollen.

Measures overlie the Carboniferous series, and along about one-third of the length of the Minera lodes are in contact, forming the hanging-wall in that area.

The Carboniferous Limestones and Cefn-y-fedw Series extend approximately 22 miles from the contact with the Lower Coal Measures to the Talargoch mines on the coast, and beyond Llanamon form the Clwydian Range. The Minera sett, while forming the extreme south-easterly limit of this strip of lead-bearing series, has been disrupted from it by a massive fault at a point about two miles from the contact with the Coal Measures, that is, near the north-west limit of the sett. This fault is known variously as the Denbighshire or Bala-Llaneliden fault, and it strikes roughly east and west. On the south side of the Bala-Llaneliden fault near Minera the Carboniferous Limestones have a general south-eastward dip and on the south are overlain normally by the Cefn-y-fedw Sandstones or so-called Millstone Grit. On the northern side of the fault the shift is downwards, while on the southern side it is horizontal and eastward. The Carboniferous Limestones of Esclusham Mountain rest upon the Ordovician strata of Cyrn-y-brain, a mountain rising to a height of about 1,800 ft. and situated west of Minera.

Although the fissures of Minera are called veins, actually they are fault-fissures which have been filled with mineral matter. Near to St. Andrew's shaft (about the centre of the property) the South Vein has a downthrow of over 400 ft. to the north, the Cefn-y-fedw Sandstones and shales being on one side of the vein and Carboniferous Limestone on the other. Thus, near Minera the Cefn-y-fedw Sandstone is faulted against Limestone, and south-east of Minera the Coal Measures faulted against sandstones. Immediately south-west of the run of the Minera veins the country rises steeply, as an escarpment, some 500 ft. to form the Esclusham Mountain upon which lie the Park, Pool Park, South Minera, and other veins previously mentioned.

There are two well-defined veins in the Minera sett, known variously as North and South, or Red and Main. From the South Vein branch the White Vein and several fliers. The average dip of these is about 80° north-east, and the strike approx. 40° south-east and north-west. Near to the Meadow shaft the two main veins are connected by an important cross-vein known as the Marion String and along this fissure some exceedingly valuable deposits of both galena and blende were located.

The Ordovician strata—known locally as "blue stone"—was cut by Taylor's shaft (about the middle of the property) at a depth of 810 ft. below surface (850 ft. O.D.) and again in the Meadow Shaft at 1,140 ft. depth. Curiously, Roy's Shaft—situated between the two shafts mentioned—was sunk to a depth of 1,015 ft., but did not meet the shales. It was considered locally that when the shales were reached the Minera lodes would be cut off. The writer, however, is by no means convinced that this belief was justified; certainly it was not proven. Such a belief assumes that a 400 ft. down-throw did not involve the underlying Ordovician strata also, which is incredible. That the underlying strata may not have followed the same sharp cleavage as the limestones and sandstones is possible and even probable, but it is obvious that lower still the limestone on the north of the fault must be faulted in order against the Ordovician rocks on the south.

The accompanying sketch map (Fig. 6, reproduced by courtesy of the Geological Survey) of sections taken near the three shafts mentioned make it clear that the Meadow shaft was actually sunk for 60 ft. in Ordovician strata and stopped; similarly in the case of Taylor's shaft. In the case of Meadow shaft, the Ordovician shale was encountered only in the shaft itself and in the cross-cut south-west, after passing through the south vein. That the South Vein was not met with in the shaft was considered evidence that the vein ceased on making contact with the Ordovician strata, a not unnatural conclusion. This applies also to Taylor's shaft. But the writer holds that the theoretical extension of this Ordovician bed is purely presumptive and was not proved. The great difference in the angle of dip of the shale between that in Taylor's and Meadow will be noted, although these two shafts are only 960 ft. apart, and, as already mentioned, Roy's shaft, lying between the two, and deeper by 135 ft. than Taylor's, did not meet the "blue stone." A reasonable assumption is that the Ordovician strata faults downwards in irregular steps. The strength of the Main Vein in both Taylor's and Roy's shaft sections will be noticed, and also of the Red Vein (North) in all three sections. The appearance of the "New North Vein," which may be a branch of the Main Red Vein, is also interesting. The writer is of the opinion that no attempt was made to prove the extension in depth of the Minera veins, such as would undoubtedly be done in present times, and that such exploration would have been found to be amply justified.

The formation of the main Minera veins would appear to have been contemporaneous, but the Ragman vein on Esclusham Mountain appears to be of more recent age. This caunter vein may be traced for over two miles and is strongly marked on the surface, yet, although several good ore-bodies are stated to have been found therein, as far as it has been explored it does not appear to have proved very profitable. Its strike, dip, width, and mineral content indicate extraordinary uniformity, but the filling, it is said, consisted largely of sand, clay, and rock breccia from the walls. It might be interesting to know what exactly occurs in this vein at depth.

Dr. Bernard Smith, in the special report previously quoted, mentions the possible screening effect of the Bala-Llanelidan fault, which inclines northwards, upon the vertically-rising magmatic solutions, and suggests that this accounts for the fact that whereas the area immediately north of the fault would appear to be comparatively barren, the rocks on the south side in the vicinity of Minera are rich in lead and blende. The north inclination of the Minera fault would have a similar effect. It must be pointed out, however, that no appreciable exploration appears ever to have been carried out on the Llandegla moorland, which lies between the Bala fault and the admittedly rich district of Bod Idris, Alltgymbyd, and Llanarmon. With the exception of the "Old Lead Mine," close to Maes Maelor Farm, the writer is unaware of any attempt to explore this region. Cefn-y-fedw Sandstones cover the Carboniferous limestones in this neighbourhood, and although the Pant-y-gwlanod, Creigiog, Maes-y-pwll, Bod Iris, etc. veins have all produced considerable quantities of ore, no attempt has been made to follow these eastward under the Cefn-y-fedw Sandstones, where they cease to be recognizable on surface. The writer is aware that one fault at least is strongly marked across the heather-clad moorland and believes that ore-bearing fissures will be located in the underlying limestones, which in this region attain their estimated maximum thickness, viz. 2,880 ft. The difficulties confronting the men who sank the "Old Lead Mine" shaft on this wild moorland must have been well-nigh insuperable, and the writer strongly suspects that water troubles put an end to operations which might have proved successful in proving the existence of ores.

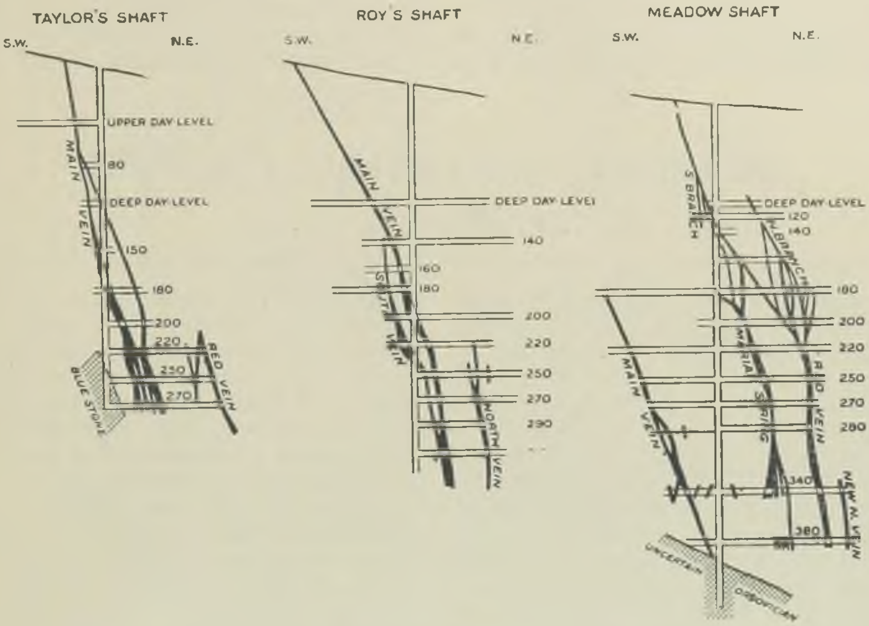


FIG. 6.—SECTIONS THROUGH MINERA MINE SHAFTS: DEPTHS IN YARDS.

CONCLUSION.—The writer trusts that this necessarily abbreviated description of the Minera and district lead mines will focus attention upon this once exceedingly rich area. The plans, which, in the case of Minera, were well kept, suggest that large portions of the ore-masses have been but partially exploited;

for example, the floor of the deepest level in the Minera mines (1,300 ft.) has been stoped to a depth of 3 ft. below water for a length of 400 ft. and below this a condiderable extension of the ore-body is clearly indicated. Probably, if the water problem had not been an ever-present source of anxiety, these ore-bodies would have been explored more fully in depth. This may also explain the seeming neglect in past years systematically to explore the parallel mineral veins in the mountain range on the south-west and also the extension in depth of the Minera veins. The Meadow shaft was one of the chief pumping shafts, and the Cornish pumps were fully occupied in keeping the water down even to 1,300 ft. It is, therefore, understandable that the management had no desire to risk a further influx of water as the result of tapping the mountain range behind the main veins. In the case of the numerous other properties none of these has been explored except to shallow depths.

The area thus briefly reviewed would appear to warrant systematic exploration and with the ample supply of cheap electric power now available on the spot the difficulty that so persistently hampered operations should now be minimized considerably. It is, of course, too early to discuss the probable effect upon the Minera-Llandegla-Llanarmon district of the Halkyn District drainage tunnel, but when the tunnel eventually reaches the Llanarmon and Yale district—four and a half miles from Minera—it would appear probable that this drainage will have, at least, a beneficial effect upon the contiguous ore-bearing district.

MODIFIED FLOTATION CIRCUITS

By R. R. KNUCKEY, A.I.M.M.

The author advocates the use of tables and classifiers before flotation in plants for the treatment of certain ores.

The progress made in mineral flotation has tended completely to displace gravity ore-dressing methods in many plants and, in consequence, the use of concentrating tables and hydraulic sizers or classifiers appears to be declining from favour. It is the opinion of the writer, however, that tables and sizers still have a valuable place in plant designed for the treatment of many ores and this is especially so where the ore itself has a high specific gravity necessitating fine grinding to secure a good recovery.

Concentration by flotation methods has proved so very successful a means of winning mineral wealth previously considered irrecoverable by gravity methods that many operators have lost sight of the possibility of recovering the mineral at successive stages in grinding. In other words, the modern tendency is in favour of flow-sheets that ignore recovery until the actual flotation cell is reached.

When classifying devices, such as are used in fine-grinding circuits for the removal of that portion of the ore considered fine enough for the flotation plant, are considered, it must be confessed that, at best, they are often faulty. It may safely be asserted that in almost every return of sands from the classifiers to the ball- or tube-mill a comparatively large percentage of ore sufficiently finely crushed to leave the circuit is being returned for further grinding. This not only calls for unnecessary power consumption, but, what is more serious, it means a diminished chance of high recovery with some ores. Very frequently it will be found that the finest grains in the classifier sand returns are the richest in mineral and these, after repassing through the grinding circuit, become still finer, in which state they are the cause of losses in the flotation plant, where, in any case, 100% recovery is not obtained. In circuits employing gravity separation, however, it is obvious that every grain of mineral won before flotation represents 100% recovery for that particular grain, whereas in the flotation cell after the particular particle has been slimed down to, say, minus 600 mesh, as frequently happens in some grinding circuits, the full recovery of the original grain is not practicable.

After the feed has been sized and graded, modern concentrating tables with studied riffling and feed distribution are capable of recovering mineral fine enough to pass a 200 mesh screen. Vanners are consequently no longer required as an adjunct to the use of concentrating tables.

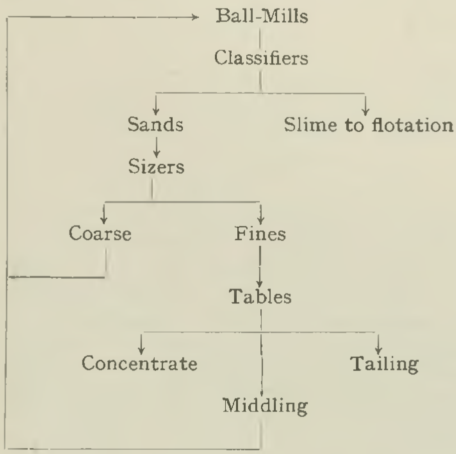
The rapidity at which recovery can be effected and the tonnage of feed that can be handled on an equal floor space by all-flotation plants, however, are factors that influence operators to decide for this type of equipment in preference to using the combination of tabling and flotation. More especially is this so when flotation can be used to recover the mineral in a comparatively coarse state—say, at plus 100 mesh.

It should also be remembered when milling low-grade ores that the percentage weight of the ore that can be removed as a concentrate by gravity methods is generally inadequate to lower the grinding costs sufficiently to compensate for the outlay of installing and operating the tables, jigs, etc. All ores, however, are not low-grade and, although they might and frequently do require fine grinding in order to dissociate fully their mineral constituents and effect a high total recovery, nevertheless it is possible frequently to remove a portion of the mineral in a coarse or granular state and in most cases it is desirable to do so and thus effect a full 100% recovery of the freed mineral as soon as it is liberated.

In the course of a recent examination of the sand returns from a standard classifier in a plant milling high-grade ore, from which a high percentage of the mineral could only be recovered after fine grinding, it was found by sizing tests that the sands in question contained quite a large percentage of minus 150 mesh material. This portion was already fine enough for the flotation plant, but, by reason of its high specific gravity, it did not flow over the slime discharge of the classifier. A test run through a sizing machine of a well-known make, using these classifier sands as feed, showed that practically all the fines could be removed *en route* to the ball-mill and that the products from the sizer spigots delivering the fines carried a large proportion of the total mineral present in the feed. These spigot discharges formed an ideal feed for tabling and it was found that a larger percentage of the mineral could be removed in a coarse state at this early stage and thus effect a full 100% recovery and save the cost of further grinding and also the unavoidable loss in recovery entailed in passing them on to the flotation plant.

The following provides a more exact illustration of what, it is suggested, would be an improved method of concentration for these ores. It was found that the last three spigot discharges accounted for 32% by weight of the feed to the sizers and contained 75% of the total free mineral in the classifier sands. In other words, the discharge was suitable table feed and the free mineral in it could be recovered there and then by gravity concentration, without returning it to the ball-mill.

It should be remembered, in addition, that tables can be used to reject from the circuit much material that does not carry sufficient mineral value to pay for further crushing or flotation and, where this is possible, they have the further advantage of reducing the load on the flotation cell. The following is a flow-sheet suggested by these remarks:—



The idea of using tables in the grinding circuit for recovering any free mineral from classifier sands prior to flotation is not new. A well-known mill equipment company illustrates the practice in many of their flow-sheets, but the possible use of the sizer as a secondary classifier for removing fines from the rake discharge of the primary classifier has, perhaps, not been widely realized.

In the opinion of the writer this is a point well worthy of investigation by operators when milling ores of a high specific gravity, where, as often happens, the operating company owns both mill and smelter. In treating a lead-zinc ore, for example, a drop in the lead tenor of the table concentrate, as compared with that possible by flotation methods, is not a serious point when recoveries are raised and where the concentrate has not to bear the cost of transport and custom smelting charges.

The adage—" take your mineral as soon as you can get it "—is more closely followed by the method outlined than by allowing the free mineral in the sand discharge to return for finer grinding.

LIGHTNING.—I

By JOHN F. SHIPLEY, M.I.E.E.

The present article is the first of a series of four and in it the author describes some features of lightning in general terms, giving, in addition, certain fundamental dimensions. In future articles he will deal with the formation of storms and the separation of electricity, the protection of power plant, life, and property, and the nature and causes of breakdowns of electrical plant due to lightning.

It is not without pleasure that the author is able to discuss the subject of lightning in THE MINING MAGAZINE, for he has found that mining engineers, above all others, have the necessary experience and observational capacity to appreciate properly the causes and effects of lightning and he is indebted to them for much encouragement in these studies in the past. The fact that mining engineers frequently see under the very best conditions the phenomena described does not always imply that the correct or, at least, the most modern explanation is given when demanded. The very beauty and grandeur of a lightning storm often mask the elemental causes of it. Only within the last three or four years has any reliable theory been formed which explains lightning phenomena satisfactorily and which has enabled them to be reproduced artificially on such a scale as to prove the soundness of the basis on which the theory has been established.

The chief exponent of the modern theory is Dr. G. C. Simpson, Chief of the Meteorological Survey and an eminent physicist. His views, based on experimental facts and experience abroad and an intimate knowledge of the air and its ways, are revolutionary and have not been effectively opposed. In the author's opinion they satisfy observed facts more closely than any others. The reader is therefore recommended to forget all he has heard of or read in the textbooks and to start with an open mind to assess these views by his own experience and to check the statements, as far as possible, by his own observations. The essential feature of the theory is that clouds are perfect electrical insulators and that air is a slight electrical conductor. This is the exact opposite of what has previously been considered correct, but experiment has proved that the new theory is right.

It is proposed to describe, first, the principal characteristics of a lightning flash and its approximate dimensions, so far as these have been determined by recent observations and experiments. The causes of lightning discharges and their effects will be dealt with next and, finally, the latest methods in use for the protection of power transmission lines and electrical equipments associated with them against damage from lightning discharges will be explained and discussed.

The voltage of a lightning flash is of the order of 1,000 million volts and it lasts from about 20 millionths of a second to 1,000 millionths of a second.[1] Discharges of 100 micro-seconds are quite common. The greatest intensity of pressure usually occurs in the first few micro-seconds. Instruments have been devised which produce visible records of natural lightning flashes and several such records copied from various sources are shown in Fig. 1. All these show surges which are impressed upon power or telephone wires and from the scale it can be seen how steep the wave is, as measured in millionths of a second.

The length of a flash may be anything from a half to three miles, perhaps more. Its brightness lingers an appreciable time on the retina of the eye and this brightness is due to the conducting path of air, which is kept intensely hot by the electric current. This current may reach a value of some 100,000 ampères, but it averages about 16,000 ampères. Although its duration is very brief the hot air path may be utilized again and again for other discharges, so that frequently several flashes follow the same air path one after the other. This can be seen in Fig. 2 and is shown also in Fig. 6*c*. The intense heat generated thus causes an equally sudden expansion of the air in the vicinity of the path taken by the discharge. The same sudden expansion is the origin of thunder. The rolling of thunder is explained by the fact that the sound waves are generated practically simultaneously along the whole path followed by the lightning flash, although the beginning and end of the path may be several miles apart, so that the time taken by the sound waves to reach the observer varies accordingly. Reflection or echo effects also result in reverberation of the sound waves, thus prolonging the rumbling and rolling of the thunder.

[1] A millionth of a second is called a micro-second.

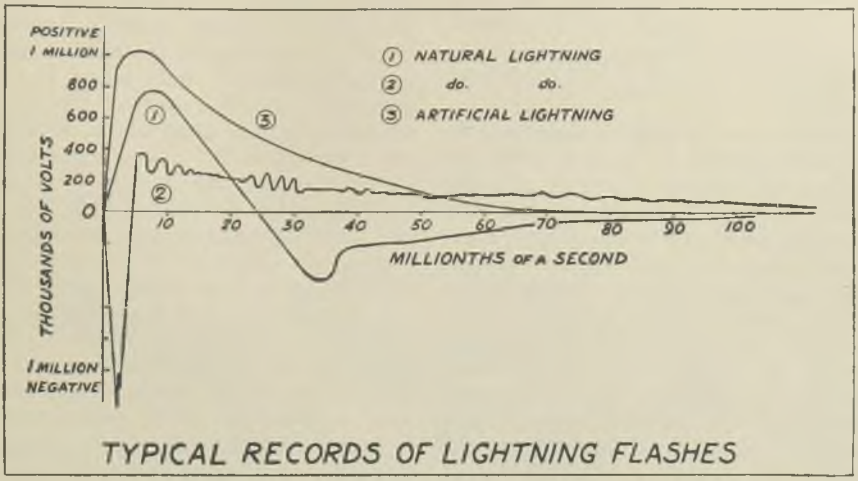


FIG. 1.—OSCILLOGRAMS OF LIGHTNING WAVES.

The disruption of posts and trees when struck by lightning is due to the sudden generation of steam or the expansion of air, which similarly accounts for the violent stripping of clothing from a person and the dislodging of chimneys and brickwork. The jet of steam which is caused by heat when lightning penetrates wet earth can be seen when there is a suitable background and in the absence of wind looks like a "plume" cloud, about 50 ft. high. If the ground is clay, sand, or gravel the path of the lightning in it is generally similar to that of the roots of a tree, i.e., branching, so as to distribute itself into the greatest area possible. These paths are usually vitrified by the intense heat.

The heating effect of the current is also responsible for the melting of metals that may form part of the lightning path. This current is in most cases a direct current and it flows through the conductor of hot air quite normally. It rises to its maximum value in such a short time (a few millionths of a second) that it acts in a similar manner to a high-frequency current, but, nevertheless, it is a true continuous current which rises to a maximum quickly, and dies away more slowly. The lightning path is formed in the air irregularly and variations of an extremely rapid nature take place, and it is these variations, superimposed upon the normal discharge wave, that are considered by some to be the cause of the crackles (called "atmospherics" or "statics") which one hears in a wireless receiver, and which interfere with wireless telegraphy and telephony so badly. Others are of opinion that the discharge column itself radiates energy as a wireless aerial does, so causing disturbances.

If the voltage of a flash is so high and the current is so enormous, it is reasonable to ask what the energy of a single lightning flash amounts to. This has been ascertained to be of the order of 3,000 k.w. hours (value, say £12 10s. at 1d. per unit). Although the total quantity of energy appears small, it is necessary to consider the limit of time as well as energy. If the energy mentioned were liberated in one second, the *rate* of

FIG. 2.—BAND LIGHTNING.

discharge would be equivalent to over 10 million kilowatts, whilst the actual rate is some 50,000 times as high, owing to the exceedingly minute period of time taken by the discharge.

The author has watched innumerable lightning flashes in the Andes of Bolivia and on one occasion, during a period of some four hours, he counted flashes at the rate of twenty a minute, and this rate continued throughout the time mentioned. On this basis there must have been, during those four hours, an expenditure of nearly 15 million k.w. hours, which is of the same order as the consumption of a small town, say Hastings, for a whole year. It has been estimated that about 1,800 lightning flashes are occurring between the atmosphere and the earth at any one moment. Rating this at 100 flashes a second, and using the figures mentioned above, the wastage of electrical energy by lightning alone is of the order of nine and half a million million units a year. Even if we were able to sell this quantity at the ridiculously cheap rate of 100 units a penny, it would be worth £400,000,000.

There seems to be no possibility yet of harnessing this store of natural electrical energy in the atmosphere. The only way apparently possible would be to collect all the rain that falls during lightning storms, at a reasonable height, and store it for use in hydro-electric plants. This is so obviously impracticable that the only excuse for mentioning it is the intimate connexion of rain storms with lightning, which the author wishes to elaborate later.

Lightning appears to be as frequent over the sea as over the land, but at sea its appearance is mostly nocturnal, while on land storms occur generally during the afternoon. Fig. 3 is a map of the earth showing the prevalence of lightning. It will be noticed that the most intense spot is the Island of Java, which, apparently, has more than twice as much lightning as any other part of the world. The next most severe spots are Northern Mexico, the Panama region, the Peruvian and Bolivian Andes, Madagascar, and the Nigerian Plateau to Northern Rhodesia. It will be seen that these are situated in the Tropics, and are places where sudden changes of altitude or contrary winds occur. Most of the sites are also associated with volcanic eruptions.

It has long been known that an electrical pressure gradient exists in the atmosphere and records of its value and variations have been kept for many years. Normally, the electrical stressing of the atmosphere causes no inconvenience, but, when the stress is concentrated, it makes itself felt by straightening out light fibres, such as cotton and human hair. This concentration of electrical stress often occurs on mountain tops all over the world, but particularly in those regions already mentioned, and, besides its effect upon the hair, it causes a feeling of apprehension, which the writer has experienced on many occasions. On the Plateau of Bolivia (altitude, 12,000 ft.) where the almost level plain is perforated at intervals by small, rocky hills, the author has experienced the electrical stress frequently. During the day a slight rushing noise, as of wind, is heard, while one's hair stands on end, and at night the purple brush discharge to one's nose, ears, and hands (especially if the latter are held up) are visible signs of the stress.

The same manifestation of the electrical stress (brush discharge) is often apparent at sea, moving about on mast tops and yard arm ends. This type of brush discharge is sometimes associated with that form of lightning usually described as a "globe of fire." A ball or globe of fire, varying in size from 4 in. diameter to a yard, and usually (not always) spherical in shape, has been seen so frequently that it is not possible to disregard it, although its origin, persistence, and usually sudden and explosive disappearance, have not yet been satisfactorily explained. The brush discharge is a well-known feature in all electrical high-tension laboratories (with which the author is well acquainted), but a ball of fire in free air, has not yet, to his knowledge, been seen there, or been observed anywhere else, except during a lightning storm.

The most common form of lightning discharge is that known as "forked" lightning. This type may occur with its forks pointing to the earth, or vice versa. The former is more usual. The reader should note the similarity between the structural shape of a flash of lightning of the most prevalent type (Fig. 6*a*), and that of a growing tree, or of a river flowing in a plain, or of a fibrous root in thin soil. The natural inference from these observations is that the principle of the action is in all cases similar, i.e. a stress exists throughout the space concerned, causing a tendency to grow or flow, and slight irregularities

Fig. 3.—Relative Occurrence of Thunderstorms. From the "Manual of Meteorology," by Dr. Napier Shaw. Figures denote thunderstorm-days per year.

occur in the material occupying it, causing the forking and variations.

A flash may also occur between two portions of the same cloud without the flash reaching, or even tending to reach, the earth. It is stated that flashes sometimes occur between two clouds, but it is very difficult to get a photograph so that it can be clearly seen that two entirely separate clouds are concerned. Fig. 5 is a photograph taken by the author last year in Nigeria, which shows some discharges of this nature high up between portions of large cumulo-nimbus clouds.

What is called " sheet lightning " may be the flood lighting of the clouds by a succession of flashes, or it may be the cloud lighted up by flashes in its interior. One observer has described an effect somewhat akin to the aurora borealis, which actually covered the whole surface of a cloud, but such an occurrence is very rare. Many observers are so overcome by the suddenness and extraordinary violence of a lightning storm that their observations are vitiated, but several peculiarities are to be noted and one of these is usually described as " chain " or " pearl " lightning. This is a flash that shows a string (not always regularly spaced) of bright portions of balls along a flash of otherwise usual shape. These are almost certainly due to the flash being seen partially " end-on," as shown in Figs. 6*e* and *f*. An observer at x would see a bright flash with very much brighter portions at G, H, K, L, and M. The human observer sees the flash in one plane, but the flash is at liberty to take any path

Fig. 4.—Normal Lightning.

FIG. 5.—CLOUD LIGHTNING IN NIGERIA.

between earth and cloud that satisfies the stress conditions. As stated previously, it takes a chance path through the stressed atmosphere.

With the exception of ball lightning and the sheet of flame mentioned above, there is no material difference in the lightning flashes, although they may be of varying shapes, as the illustrations in this article show, but all these variations will receive attention later.

In ancient times lightning was frequently observed and many apt references to it remain to this day. Many of the references in

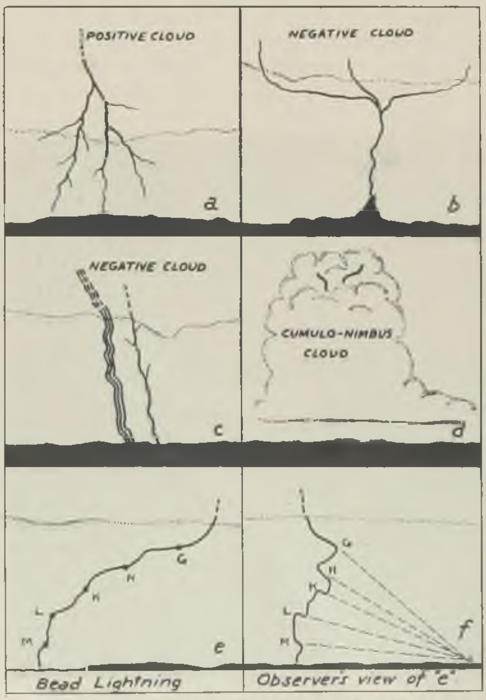


FIG. 6.—VARIOUS TYPES OF LIGHTNING.

Holy Scripture will be familiar to readers. Horace noted that tall trees and high trees were more frequently overthrown than lower ones and that lightning always occurred near mountain ranges. Herodotus records a speech by Artabanus to the effect that lightning always struck the largest animals, the highest houses, and the tallest trees. All these observations are correct and are used in the design of transmission lines at the present time, as will be shown later.

The Ancients stated that the oak was struck much more frequently than the beech, and hence was considered more sacred to the gods. This might be the case provided that the root structure of the oak gave a better path to earth than the beech, but general observations show that lightning has no particular preference for one kind of tree rather than another. On the other hand, the resistance to earth of any projection from the ground is of great importance. If lightning should by chance strike a metallic vein in the earth, the damage, if any, would be confined to a very small area on each side of the vein, and the rise of voltage on the ground would be comparatively small owing to the wide area made available for dissipating the energy of the discharge quickly. A wooden pole just let into the ground would, if struck, provide a very poor electrical path to earth, and therefore anyone standing near it would probably be raised to a very high voltage which would most likely prove fatal. An aggravated example of this is provided by the case of a wooden post fence with horizontal iron wires situated in open country. This forms a rough kind of transmission line and if the wires are not specially earthed, and the line is struck, the sudden increase of voltage is so great, and persists so long, that the voltage rise all round each post is correspondingly great, and any persons or animals near the fence would be killed. Many hundreds of cases where this has happened have been recorded. If, however, the fence wires had been earthed at intervals to substantial earths of a type mentioned later, very little risk would have been run. The author recollects two cases where a similar dangerous rise of voltage occurred in a tropical country. A European and two boys were surveying with a metal chain which was stretched out on the wet ground on a flat, treeless area. A flash of lightning occurred about half a mile away, just when the men were picking up the chain for a new position. They were all knocked flat and suffered from shock. Another time, the author had 20 men caulking the joints of a 3 ft. diameter pipe-line, about half a mile long. Water was running down this pipe-line to keep it clean, and every one of some 150 concrete and masonry supports was dripping wet. A storm approached and the hills near by were struck. The flash was not visible to the writer, but all the men near the pipe-line were thrown violently six to ten feet backward from the pipe.

Lightning may be caused in several different ways. By far the most frequent cause is the heat storm, but lightning is also associated with volcanic eruptions and with dust storms. In heat storms the atmosphere acts as a huge electrical generator in which rising air and falling rain interact. The breaking up of the raindrops causes a separation of electricity. In a dust storm a different thing happens, there being relative movement between dust and the air, and it is this that causes electrification. Some research has been made recently in this connexion, with a view to finding out whether coal dust blown through the air violently will cause sparking. The results show that this is most certainly the case, pressures of over 10,000 volts having been reached with quite small apparatus.

Lightning from dust storms has also been observed on a transmission system in Nigeria with which the author is connected. During the dry season there, when revolving duststorms have approached the transmission line, a discharge has been noted and apparatus broken down in exactly the same way as during an ordinary electrical storm in the wet season.

The reader may recollect how in Rudyard Kipling's story "False Dawn," in "Plain Tales from the Hills," there is an excellent description of a bad dust storm, which caused lightning and thunder. It has also been recorded that during the eruption of Mont Pelée, in Martinique, the volcanic dust shot upward through the air, and caused lightning to play about the summit of the column.

It would be interesting to hear from readers whether they have observed any occurrences similar to those described above.

THE MEASUREMENT OF AIR-COMPRESSOR EFFICIENCIES

By H. G. SMITH, B.Sc.

A description of the methods of determining compressor efficiencies and of the means by which defects may be detected.

Introduction.—In these days of economic stress and industrial depression, it is essential that the cost of production should be kept as low as possible, while, at the same time, the safety of the miner must not be impaired. The winning of any mineral is a complex operation, many factors having bearing upon its ultimate "pit-head cost." Not the least of these is the cost of compressed air power. Professor S. J. Truscott once stated that [1]: "If it were put in terms of weight, it would be found, in round terms and leaving out the open mines, that for every 5 tons of mineral raised, something like 1 ton of compressed air was sent underground." The efficiencies of compressed air power systems in mines are notoriously low, many showing an overall efficiency of less than 10%. Admittedly, the chief cause of this is due to transmission losses, but, at the same time, the compressor, which is the generator of the power, is worthy of some consideration. As is well known the effect of any inefficiency taking place early in the train of cost accumulations is intensified when the end of the train is reached.

[1] *Trans.* Inst. Min. and Met., Vol. xxxviii, p. 146.

The skill of the mechanical engineer has made high compressor efficiencies common, but, if these high efficiencies are to be maintained, frequent compressor tests should be made. The object of this article is twofold :—

1.—To indicate the simplicity with which the various efficiencies of a compressor can be determined, and to discuss their relative importance from the point of view of the mine manager.

2.—To point out some of the means available for the detection of defects in the working of a compressor.

Air-Compressor Efficiencies.—In the testing of air-compressors the following efficiencies are usually considered :—

1.—Volumetric Efficiency.
2.—Compression Efficiency.
3.—Mechanical Efficiency.
4.—Overall Efficiency.

Meaning and Determination of the various Compressor Efficiencies.—

1.—Volumetric Efficiency.—This is usually defined as the ratio of the volume of air taken in on the suction stroke, to the piston displacement. This definition takes no account of the temperature factor, and hence is only applicable to approximate measurements. What is known as the *delivery efficiency*, which is the ratio of the weight of air delivered per minute to the weight of air (at suction conditions) displaced by the piston per minute, gives a far more accurate standard of comparison.

There are four principal methods of measuring the quantity of air delivered, namely :—

a.—The Receiver Method.
b.—The Orifice Method.
c.—The Direct Metering Method.
d.—The Indicator Card Method.

a.—Receiver Method.—This method of ascertaining the quantity of air delivered is simply an application of the elementary gas laws.

It is well known that :—

$$PV = WRT \quad \ldots\ldots\ldots\ldots \quad 1.$$

where : P = pressure of the gas in lb. per sq. ft., V = volume of gas in cu. ft., W = weight of gas in lb., R = gas constant in ft.-lb. per lb. of gas, and T = absolute temperature of the gas.

Supposing we have a receiver of capacity C cu. ft., containing air at a pressure of P_2 lb. per sq. in. and a temperature of T_2° absolute. More air is now pumped into the receiver until the pressure becomes P_3 lb. per sq. in., and the temperature T_3° absolute. The weight of air pumped into the receiver is given by :—

(final weight of air in the receiver) — (initial weight of air in the receiver).

Now from equation 1 the final weight of air in the receiver

$$= \frac{144CP_3}{RT_3} \text{ lb.}$$

and the initial weight of air in the receiver

$$= \frac{144CP_2}{RT_2} \text{ lb.}$$

Hence by subtraction the weight of air pumped into the receiver

$$= \frac{144C}{R}\left[\frac{P_3}{T_3} - \frac{P_2}{T_2}\right] \text{ lb.}$$

Now suppose the suction conditions be P_1 lb. per sq. in. pressure, and T_1° absolute temperature. Then the volume of air, referred to suction or " free air " conditions, pumped into the receiver

$$= \frac{RT_1}{144P_1}\left(\frac{144C}{R}\left[\frac{P_3}{T_3} - \frac{P_2}{T_2}\right]\right)$$

$$= C\left(\frac{T_1}{P_1}\right)\left(\frac{P_3}{T_3} - \frac{P_2}{T_2}\right) \text{ cu. ft. } \ldots\ldots\ldots 2.$$

It would probably be as well at this point to indicate the method of calculating the quantity of air displaced by the piston. Let :—A = area of cross-section of the piston in sq. in., a = area of cross-section of the piston rod in sq. in., L = length of stroke in ft., N = number of strokes per minute. Then, assuming the compressor is double-acting and the piston rod is on one side only of the piston, we have piston displacement

$$= \left(\frac{A + (A - a)}{2} \times \frac{1}{144}\right) \times L \times N.$$

For a single-acting compressor the piston displacement would be

$$\frac{A}{144} \times L \times N.$$

N, the number of strokes, must not be confused with the number of revolutions per minute. In the case of a double-acting compressor the number of strokes per minute will be twice the number of revolutions per minute, whilst with a single-acting compressor the number of strokes is the same as the number of revolutions.

A very common method of determining the quantity of air delivered is to pump up the receiver from atmospheric conditions to working conditions, measuring the initial

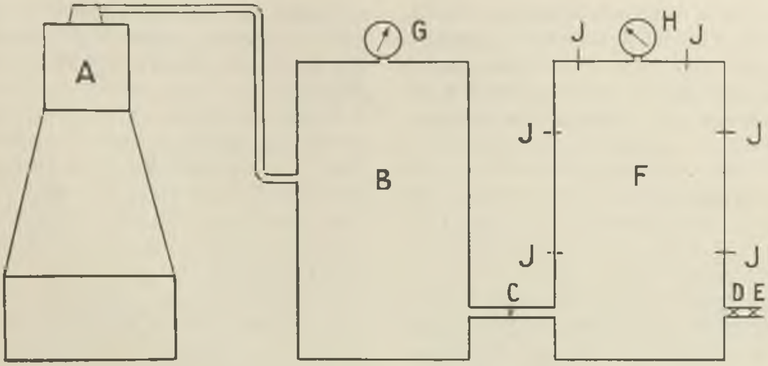


FIG. 1.

and final temperatures and pressures of the receiver, and counting the number of strokes of the compressor. Obviously, this is a very doubtful method of procedure, working conditions only being reached at the end of the test. Hence the resulting efficiency obtained would be that for the mean of the two limiting pressures. A much fairer method to adopt is to pump up the receiver from, say,

TABLE I

Data and Readings

Duration of test in seconds	80
Revs. during test	480
R.P.M.	360
Suction pressure in lb. per sq. in. (P_1)	14·7
,, temperature in ° centigrade (T_1)	14
Initial receiver pressure in lb. per sq. in. gauge (P_2)	40
,, ,, temperature in ° centigrade (T_2)	13·2
Final ,, pressure in lb. per sq. in. gauge (P_3)	60
,, ,, temperature in ° centigrade (T_3)	14·5
Capacity of receiver, etc. in cu. ft. (C)	82·64
Diameter of L.P. cylinder in in.	9
L.P. cylinder stroke in in.	7

The volume of free air delivered during the test

$$= C\left(\frac{T_1}{P_1}\right)\left(\frac{P_3}{T_3} - \frac{P_2}{T_2}\right)$$

$= 111$ cu. ft.

The volume of free air delivered per minute

$$= 111 \times \frac{60}{80} = 83{\cdot}25 \text{ cu. ft.}$$

The volume of air at suction conditions displaced by the piston during the test

$$= \frac{A}{144} \times L \times N = 123{\cdot}7 \text{ cu. ft.}$$

The volume of air at suction conditions displaced by the piston per minute

$$= 123{\cdot}7 \times \frac{60}{80} = 92{\cdot}8 \text{ cu. ft.}$$

$$\therefore \text{ the Delivery Efficiency } = \frac{83{\cdot}25}{92{\cdot}8} \times 100 = 90{\cdot}0\%.$$

5 or 10 lb. per sq. in. below working pressure to an equal increment of 5 to 10 lb. per sq. in. above working pressure, at the same time measuring the initial and final temperatures of the air in the receiver, and also the number of working strokes of the air-compressor. The suction or atmospheric conditions must also be measured.

The readings and observations given in Table I were made in a delivery efficiency test on a two-stage single-acting Reavell air-compressor, using this second receiver method.

When two receivers are available a very accurate method of measuring the volume delivered has been devised. The delivery pipe from the compressor is coupled to the receiver *B* (Fig. 1) and the discharge from *B* through a valve *C* to a second receiver *F*, which is fitted with a pressure gauge *H* and several thermometer pockets *J*. The discharge from F passes to the atmosphere through a valve *D* and a cock *E*. With the valve *C* closed the receiver *B* is pumped up until the working pressure is registered by *G*. The receiver *F* is then opened to the atmosphere and the valve *C* is adjusted so that the quantity of air escaping from *B* is such that the pressure indicated by *G* is constant and at the working pressure. When conditions have become steady, the mean of the temperatures at *J* is noted and also the pressure gauge *H* is read (in this case it should be atmospheric), giving the values T_2 and P_2 in equation 2. The cock *E* is then closed, followed by the valve *D* to minimize the risk of leakage. The cock permits the more accurate timing of the commencement of pumping, because of the rapidity with which it can be closed. *F* is now being filled and the pressure indicated by *G* is kept constant by manipulating the valve *C*. When the value of the pressure indicated by H has reached a predetermined figure, or is equal to the pressure indicated by G, the time is again noted and the valve C is closed. The mean temperature of F is again determined, thus the values of T_3 and P_3 in equation 2 are known. The number of strokes of the compressor during the test are counted. The need for the measurement of the final temperature T_3 can be obviated if, when the valves C and D are closed and no leakage occurs, the air in F is allowed to cool down to atmospheric temperature or the initial value and the pressure indicated by H noted.

The scope of the receiver methods of measuring the air delivered is limited to the smaller compressor units. Apart from slight leakages the chief source of error is the measurement of temperature. The initial temperature can possibly be determined fairly accurately, but, if the delivery air is hot and the capacity of the receiver small, the final temperature will be high and the error in its measurement large. The most accurate results will be obtained if the capacity of the receiver is large and the delivery temperature is comparatively low, so that the range of temperature experienced during the test is small. The principal advantage of the double receiver method, of course, is the obviation of the need for the measurement of the final temperature. The exact measurement of the capacity of the receiver is a very difficult matter and errors of 1 or 2% may be easily incurred. When, as is usual and correct practice, more than one test is carried out sufficient time must be allowed to elapse between the tests to permit the walls of the receiver to cool down to atmospheric temperature, otherwise serious errors to the credit of the compressor will accrue.

In spite of all these possible sources of error, using only the instruments likely to be available at most mines, i.e. pressure gauges, thermometers, revs. counter, stop watch, etc., the receiver method enables the quantity of air delivered to be determined with reasonable accuracy.

b.—Orifice or Nozzle Method.—It is a very common belief that the orifice or nozzle method of measuring air volumes is only applicable when dealing with large quantities of air. This is not the case, however, for, provided proper precautions are taken, quite small volumes can be measured by these means. The method is based upon the fact that, when air is passing along a duct, and comes to a constriction the air suffers an increase in velocity, which is also accompanied by a related decrease in static pressure. By measuring this pressure difference, it is possible to calculate the velocity of flow of the air through the narrowed portion and, knowing the flow area, the volume of air passing in unit time through the constriction can be calculated. For various well-known reasons, the actual velocity is less than the theoretical velocity, and hence the actual volumes must be less than the calculated volumes. The calculated volumes must be multiplied by a factor known as the coefficient of discharge (generally denoted by the Greek letter μ), which factor varies with the form of orifice. The coefficient of discharge μ cannot be found by calculation but only by experiment. It is probably most conveniently determined by passing super-heated steam through the orifice, noting the fall in static pressure in the normal fashion, and weighing the condensate to determine the volume of flow.

When an orifice is used to measure the volume of air flowing, there are three cases which arise.

(1) When the ratio of the pressure after the orifice (P_2) to the pressure before the orifice (P_1) is greater than 0·9,

i.e. $$\frac{P_2}{P_1} > 0{\cdot}9.$$

(2) When the ratio of the pressures after and before the orifice is less than 0·9 but greater than a certain critical value,

i.e. $$0{\cdot}9 > \frac{P_2}{P_1} > \text{a certain critical value.}$$

(3) When the ratio of the pressures after and before the orifice is less than the critical value,

i.e. $$\frac{P_2}{P_1} < \text{critical value.}$$

For diatomic gases the critical value is 0·528. Hence case (3) becomes

$$\frac{P_2}{P_1} < 0{\cdot}528$$

It can be shown that when $\frac{P_2}{P_1} < 0{\cdot}528$ the weight of air (W) discharged through the orifice per minute is independent of the back pressure P_2,

i.e. $$W = \mu a \sqrt{2g \frac{n}{(n+1)} \left(\frac{P_1}{V_1}\right) \left(\frac{2}{n+1}\right)^{\frac{2}{n-1}}}$$

lb. per. sec.

where :—W = the weight of air discharged per second in lb., P_1 = pressure before the orifice in lb. per sq. ft., T_1 =

temperature of the air before the orifice in ° Fahrenheit, μ = discharge coefficient of the orifice, a = area of the orifice outlet in sq. ft., $n = 1 \cdot 408$ since the expansion is adiabatic.

Substituting for n we get :—

$$W = 3 \cdot 895 \mu a \sqrt{\frac{P_1}{V_1}}$$

But $$P_1 V_1 = RT_1$$

$$\therefore W = 3 \cdot 895 \mu a \frac{P_1}{\sqrt{RT_1}} \quad \ldots\ldots 3a.$$

Since T_1 is measured in ° Fahrenheit, R, the gas constant, equals 53·2. Hence

$$W = 32 \cdot 042 \mu a \frac{P_1}{\sqrt{T_1}} \text{ lb. per min.} \ldots 3.$$

Let w = weight of 1 cu. ft. of suction air in lb. Then the actual volume of "free air" delivered

$$= \frac{W}{w} \text{ cu. ft. per minute} \ldots\ldots\ldots 4.$$

In practice the form of orifice may vary, but in all cases the above equations 3 and 4

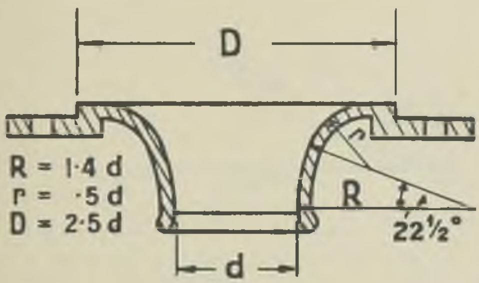


FIG. 2.

apply. The coefficient of discharge varies with the type of orifice, but, in order to avoid having to determine μ, certain orifice proportions have been designed which give only a small variation in the value of μ over a large range of sizes. This form of orifice is shown in Fig. 2. It was designed in Germany and is very popular on the continent; its value for μ lies between 0·985 and 0·995.

The delivery pipe from the air-compressor is coupled to the receiver B (Fig. 3), which is provided with a pressure gauge C, a thermometer D, and the orifice E, fitted on the side of the receiver. The orifice may be fitted in the outlet pipe of the receiver. The receiver is necessary in order that the pulsations of the compressor may be effectively damped. The orifice is opened, the compressor started up, and its speed adjusted so that the pressure gauge C is steady and as near as possible to the working pressure. When the conditions have become steady, the reading of the gauge (P_1) is noted and the temperature (T_1) at D ascertained and these values substituted in equation 3. Atmospheric or suction conditions are next determined, and the weight (w) of a cubic foot of suction air read off from Jones's tables. Hence the volume of "free air" $\left(\frac{W}{w}\right)$ delivered per minute can be calculated.

The data and readings given in Table II were collected in a delivery efficiency test on a two-stage single-acting Reavell air-compressor, using the orifice method.

TABLE II

R.P.M. of air compressor	400
Diameter of L.P. piston in in.	9
Length of L.P. stroke in in.	7
Temperature in the receiver in° Fah. (T_1)	81
Pressure in the receiver in lb. per sq. in. (P_1)	46
Suction pressure in lb. per sq. in. (P_0)	14·7
Suction temperature in ° Fah. (T_0)	57
Area of nozzle in sq. ft. (a)	0·00059
Coefficient of nozzle discharge (μ)	0·99

The weight (W) of air discharged through the orifice per minute

$$= 32 \cdot 042 \mu a \frac{P_1}{\sqrt{T_1}} = 7 \cdot 04 \text{ lb. per min.}$$

Weight (w) of a cu. ft. of air at P_0 and T_0 from tables = 0·0770 lb.

∴ Volume of free air delivered per minute

$$= \frac{7 \cdot 04}{0 \cdot 0770} = 91 \cdot 41 \text{ cu. ft.}$$

The volume of air at suction conditions displaced by piston per minute

$$= \frac{A}{144} \times L \times N = 103 \text{ cu. ft.}$$

∴ Delivery Efficiency

$$= \frac{91 \cdot 41}{103 \cdot 00} \text{ or } 89\%.$$

Size of Orifice Required.—Before carrying out a delivery efficiency test on an air-compressor using the orifice method, the approximate size of the orifice required has to be

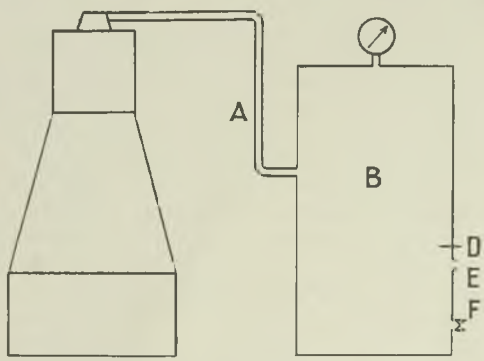


FIG. 3.

determined. A numerical example will probably best serve to illustrate this.

A compressor deals with 200 cu. ft. of free air per minute. The receiver pressure, i.e. pressure before the orifice, is 50 lb. per sq. in. gauge. If $\mu = 0{\cdot}99$, what is the approximate size of the nozzle required ?

Assume the atmosphere conditions to be, say, 60° F. and 14·7 lb. per sq. in. and the temperature before the nozzle 70° F. For the weight of air passing per second we have (neglecting, of course, the delivery efficiency),

$$W = \frac{PV}{RT} = 0{\cdot}252 \text{ lb. per second.}$$

From equation 3*a*

$$0{\cdot}252 = \frac{3{\cdot}895 \times 0{\cdot}99 \times a \times 64{\cdot}7 \times 144}{\sqrt{53{\cdot}2 \times 529}}$$

$$a = 0{\cdot}001178 \text{ sq. ft.} = 0{\cdot}1696 \text{ sq. in.}$$

$\therefore$ Approximate throat diam. $= 0{\cdot}46$ in.

Hence the standard nozzle used would be the ½ in. nozzle.

In view of the difficulties and expense in making these German orifices it should be pointed out that a simple orifice cut out in a thin plate gives quite accurate results, provided, of course, the value of μ is carefully determined. The orifice method is the most scientific and accurate method of determining the weight of air delivered by a compressor, provided the value for μ is known accurately. It is independent of most of the errors incurred in the receiver method. For example, the volume of the receiver is not required, and the temperature of the air just before it passes through the orifice can be determined quite accurately.

c.—Direct Metering Method.—This is undoubtedly the simplest and most convenient method of determining the quantity of air delivered by the compressor, provided a reliable meter is employed. There are many types of meter on the market to-day capable of registering the flow of compressed or atmospheric air quite accurately enough for the purpose of calculating the delivery efficiency. The Venturi type is perhaps best for the measurement of large volumes of air. It is a very simple and accurate instrument and, furthermore, absorbs very little pressure. The Orivent tube is simpler and cheaper than the Venturi, but is not so accurate and causes a greater pressure loss in operation.

The volume of air can be measured on the suction side, or the delivery side of the compressor. When measuring the volume on the delivery side of the compressor, the meter must be installed beyond the receiver, in order that the pulsations of the compressor are effectively damped. If the flow is pulsating, meters of the differential-pressure measuring type, i.e. Venturi, Orivent, Orifice, etc., types, will read fast. Furthermore, besides cooling the air, the receiver removes much of the suspended moisture and partially carbonized oil from the compressed air, which materials seriously impair the working of the meters.

d.—Indicator Card Method.—This method is very approximate indeed. An indicator card is taken from the L.P. cylinder as in Fig. 4. *CD* is the expansion line of clearance volume. Suction begins where this expansion line *CD* cuts the atmosphere line and ends at *A*. The ratio $\frac{V_a}{V_b}$ is sometimes taken as a measure of the volumetric efficiency of an air-compressor.

At the end of the suction stroke the cylinder is filled with air much hotter than

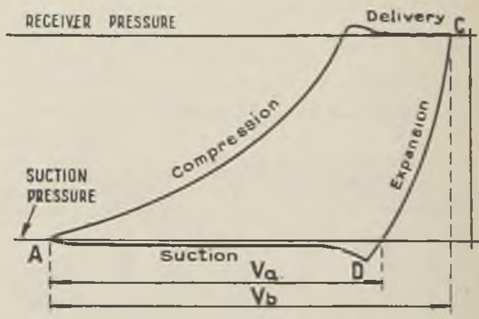


FIG. 4.—IDEAL INDICATOR DIAGRAM.

atmospheric temperature. This is, of course, due to the air drawn in meeting with the hot metal walls of the cylinder and with the hot piston and also to its mixing with the hot re-expanded clearance-volume air. Thus the weight of the air in the cylinder is much less than it would be if it were still at atmospheric temperature. The indicator card thus gives only an apparent value of the volumetric efficiency. For example, two compressors of the same size may have the same volumetric efficiency when measured by this method, although one is much better cooled and compresses more air per cycle than the other.

2.—COMPRESSION EFFICIENCY. — During compression heat is produced. By circulating cold water round the cylinders as much of this heat as possible is extracted, whilst the air is still in the cylinders. If it were possible to remove the heat as rapidly as it is generated, then compression would be performed under ideal conditions, and the efficiency of compression would be a maximum. This, however, is impossible in practice and the measure by which we fall short of these ideal conditions represents the loss in efficiency as regards the work of compression.

The compression efficiency is usually defined as the ratio of the work done on air under isothermal compression, to the work done on the air under actual conditions. Let N_c = the compression efficiency, W_i = the work done per stroke if the air had been compressed isothermally, and W_a = the work per stroke actually done on the air. Then $N_c = \frac{W_i}{W_a} \times 100\%$.

(To be concluded.)

The I.M.M. Benevolent Fund

The following further subscriptions to the Benevolent Fund of the Institution have been received during the past month :—

	£	s.	d.
A. M. Mackilligan	10	10	0
J. A. L. Henderson	5	5	0
K. J. Holman	5	5	0
P. M. Holman	5	5	0
G. F. Laycock	5	5	0
R. Pawle	5	5	0
J. B. Simpson	5	0	0
R. Pearson	3	3	0
E. L. Hay	2	2	0
J. H. Rich	2	2	0
E. R. Bawden	1	1	0
P. F. Summers	1	1	0
PER COL. R. S. G. STOKES (Transvaal) :			
R. S. G. Stokes	10	0	0
F. Wartenweiler	3	3	0
L. L. Fewster	2	2	0
F. E. Keep	2	2	0
F. A. G. Maxwell	2	2	0
T. K. Prentice	2	2	0
G. Hildick Smith	2	2	0
G. T. B. Colborne	1	1	0
O. Letcher	1	1	0
Previously acknowledged	£908	7	9
Total	£985	6	9

LETTER TO THE EDITOR

Diamond Concentrating Pans

SIR,—Mr. C. W. Walker, in his article in the October issue, raises a valuable point with regard to the use of the diamond pan for recovering other minerals and it may be interesting to put on record one actual example of such an application that came to the notice of the present writer. This was in the exploitation of an alluvial tin deposit in the Katanga province of the Belgian Congo, around about 1924. The only reason for installing this plant in preference to another was, as far as could be ascertained, the fact that the man in charge of the operations was an old Kimberley diamond digger and recommended machinery with which he was familiar. The operation, was, however, stated to be highly successful.

A. L. AUSTEN.

Villemagne, France.

BOOK REVIEWS

Explosives, their History, Manufacture, Properties, and Tests, Volume 3. By ARTHUR MARSHALL. Cloth, octavo, 286 pages, illustrated. Price 42s. London : J. and A. Churchill.

How those of us who are interested in explosives could get on without Mr. Arthur Marshall it is rather difficult to say. True we might still fall back on American, German, or French publications—German in particular—for since the late Oscar Guttmann, no British writer except Mr. Marshall has published anything very material about explosives. In 1917 Mr. Marshall wrote the first two volumes of this work and the present is in reality a large addendum to these volumes. The book is essentially a work of reference but, although it is not written for the mining engineer, no well-equipped mining office should be without it, and for this reason. Mining explosives, including the accessories such as detonators and fuse, have been entirely revolutionized since 1917. Non-freezing explosives, azide detonators, and instantaneous fuse (cordeau detonant) have encroached very largely on the old standard explosives universally employed only a decade ago. Even liquid oxygen has made a little headway in spite of the reviewer's prediction to the contrary, but he would be much surprised if present consumption should materially increase. However, Mr. Marshall himself never ventures to dogmatize or even to predict. He is indeed most judicious and contents himself with recording developments. A few of the more practical have escaped him, but this is hardly to be wondered at for even those who pass their lives in an "explosives" atmosphere cannot notice everything.

Mr. Marshall is a careful writer and a good organizer, as all of us know from his work in connexion with the Faraday Centenary celebrations. It is, therefore, not a surprise to find that the book is well arranged and his references carefully documented. If he has done an excellent piece of work, so also have Messrs. Churchill, the publishers. The get-up is the same as that of the previous volumes. The type is clear and the illustrations excellent, for the paper is of the very best. Indeed, the handsome volume would grace any library.

William Cullen.

Modern Practice in Mining. Vol. 5—Coal Machinery and Its Application. By Sir R. A. S. Redmayne. Cloth, octavo, 444 pages, illustrated. Price 30s. London: Longmans, Green, and Co.

The scheme of this book is good and the kinds of mining machinery dealt with are comprehensive, though having to do chiefly with colliery practice. There is, however, a curious mixture of old and new—it looks as though the author had been collecting notes during the last 30 odd years and had now put them together, obtaining a breccia. A plate is given showing a range of three Lancashire boilers 30 ft. long. There are ten rings of plate forming the shell. Galloway tubes are shown and stay bolts, from front to back. The drawing thus shows the practice of many years ago, and in passing it may be noted that whilst in two views the main steam pipe is shown behind the junction valves, in a third view it is shown in front.

The book is marred by mistakes, both in letterpress and drawings. In dealing with the syphon, the weight of a cubic inch of water is given as 0·086 lb. but should be 0·036. It is stated that it is advisable to have a tap placed at the highest point of the syphon pipe, to allow of the escape of air. On pp. 277–8 friction of shaft guides is dealt with, and a formula is given for its calculation. This formula is, however, that concerned with the pull in the rope due to acceleration and has not to do with friction. The diagrams of a balanced slide valve and a double beat valve on p. 258 are incorrect, as is also the drawing of a hammer pick on p. 154. One illustration is upside down. A mine plan is given without dimensions or scale. There are several drawings of dams, of which the various views do not agree.

In a long description of cables for electric transmission, there is no mention of the conductors. In one case the decimal point is placed wrongly and the mistake is carried throughout the calculation. On p. 160 it is stated that a belt or band conveyor consists of a solid band of woven cotton. Later, rubber-coated canvas is mentioned. On p. 314 it is stated that an argument in favour of erecting pumps at the surface is the freedom from the risk of being drowned out, but the pump proper must, in any case, be near the water, and is liable to be drowned, no matter where the engine is. The terms "Bessemer," "Crucible," and "Plough," given as relating to descriptions of steel used in wire ropes, are obsolete.

The section of the book dealing with mine drainage is good, though a large part of it is taken up with descriptions of old-fashioned plant. The cleaning of coal both by wet and dry methods is also well described. The author has not been well served by the publisher and the book needs a thorough overhaul.

Humphrey M. Morgans.

A Textbook of Metallurgical Problems. By Allison Butts. Cloth, octavo, 422 pages, illustrated. Price 24s. London: McGraw-Hill Publishing Co., Ltd.

This book is produced on somewhat similar lines to the well-known "Metallurgical Calculations" by the late Professor Richards, although advantage has been taken of the advances made in knowledge and in metallurgical practice since the last edition of the latter was published in 1918. The book has been written with the primary object of providing a textbook for metallurgical students, and there is no doubt that a more thorough study of metallurgical calculations should be used to present, clarify, and illustrate the practical applications of the underlying principles of metallurgical practice. The author is an Associate Professor of Metallurgy at Lehigh University, where metallurgical problem courses have been a special feature for many years, and he had the privilege of working with Professor Richards for five years.

The material offered covers a large field, including necessary introductory matters, fuels and combustion, production of blast and draught, drying, calcining, and roasting. The metallurgy of iron and steel, copper, and lead receive special attention and separate chapters are devoted to electrolytic processes, hydrometallurgy, and distillation processes. The transmission of heat, vapour pressure and temperature-pressure relations in chemical reactions, and the thermodynamics of chemical reactions also receive attention. An interesting chapter on alloys is included in which the calculation of metallographic constitution, etc., is explained in the case of binary alloys, and calculations for iron and steel are specially dealt with. After suitable descriptive matter in connexion with each subject, examples of calculations relating thereto are given in detail and a number of excellently chosen problems are set for students. There are 44 such examples with solutions, together with 309 set problems.

Excellent tables of data necessary for the solution of metallurgical problems are given and the book will undoubtedly prove of great value, not only to students but also to many practising metallurgists.

C. O. Bannister.

☞ 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.

NEWS LETTERS

BRISBANE

September 20.

Mount Isa.—The recent substantial rise in the price of lead and silver should be of considerable benefit to the Mount Isa enterprise. The average market value of the former metal for July was as low as £9 19s. 8d. In August the quotation rose £3 per ton, and has since reached £14 7s. 6d. Although this figure is still probably below the stage at which profitable mining can be carried out under ordinary circumstances, the recent improvement is decidedly encouraging. It is officially stated that the new blast-furnace has not yet been put in commission although it will be started shortly. In underground work six glory-holes in the Black Star section were operated continuously throughout August. In this part of the mine preparations were in hand to start the development of the hanging-wall ore-body on the No. 1 level. At the No. 4 level cross-cut R63 has been finished at 188 ft. and the S63 rise to No. 1 level begun. The S65 rise was commenced and at latest reports was up 21 ft. By these means access will be provided to two stopes on the hanging-wall lode. In the Black Rock section cut-and-fill stoping has been carried on uninterruptedly at No. 2 level and ore drawn from H52 stope. The G38 cross-cut was completed at 221 ft. and a rise started to obtain level for the scram drive 10 ft. above the level. In the Rio Grande section the middle lode stope has been operated continuously at No. 1 level. At No. 4 level the hanging-wall south stope has been finished and drawing commenced. The pyritic stope has been closed down. In this section, also, diamond drilling was done from underground. A horizontal hole put out east from G22 section (pyritic stope) was finished at 165 ft. after passing through the Rio Grande ore-bodies. In the same section a vertical hole has also been commenced in order to test these ore-bodies further, 100 ft. south of G23 vertical hole.

Mount Morgan Redivivus.—Following on the completion of satisfactory arrangements as to finance, with assistance from the Crown, work on the rehabilitation of the plant at Mount Morgan was begun early in July and the open-cut is now ready to produce ore. In making transport connexion it was necessary to bridge a gap left by the fire which occurred at the mine in March, 1931. The power house has been put in order and is ready for steaming. Coal for the plant is now being supplied by the Mount Morgan Company's Dawson Valley coal mine, which is being worked on tribute. The concentrating mill is being renovated and 12 of the flotation cells are being redesigned. About 100 men are at present being employed. Research work in the laboratory has been intensively pursued and a small continuous unit, for the treatment of 50 lb. of ore per hour, is being constructed.

New Goldfields.—At the Mount Wandoo mine, in North Queensland, the holder of the lease (Mr. A. Macdonald), who recently returned from a trip overseas, is making a move towards the systematic development and exploitation of his property. The local mining warden reports that contracts have been let for the sinking of the Hardman shaft (now down 130 ft.) a further 50 ft. and for 25 ft. of driving of the 65-ft. level in the Wendy shaft. Steam winding plant, compressor, and rock-drills have been installed. A ten-head battery, intended as a unit with which to begin crushing, is ready for use, but a shortage of water prevents its operation on the considerable tonnage of ore at grass. At present 36 men are employed at the mine. The newly-discovered Cracow field, in the Central district of Queensland, is attracting a good deal of attention. A township has been surveyed and attention has been directed towards sanitary and other arrangements that are being made to protect the health and welfare of the inhabitants. As to mining developments no official news is available, but from private sources it is learned that so far in several instances the reefs are expanding with depth, that values generally speaking are holding their first average, and that in a few cases they are showing some improvement. From the main reef on the field, spurs strike out in different directions for considerable distances, in most instances carrying gold. The belt of mineral country extends for miles, although it is not to be expected that the whole of it carries gold.

Mount Coolon.—The directors of Mount Coolon Gold Mines, N.L. (Queensland), in which British investors are interested, expect that the company's mill will be ready for operation in November next and that ore to be fed to the battery at the outset will yield about £3 3s. of gold a ton. About eight months after the beginning of treatment the grade of ore is expected to increase. In order to take full advantage of the present high price of gold it is intended to expedite and increase production, necessitating an expenditure in excess of the estimates given in the prospectus. To avoid anomalies, it is stated, no dividend distribution will be considered by the Board until after the contributing shares have been fully paid. It is probable that the final call on these shares will be due on March 8, 1933.

Gold Bounty.—The Federal Prime Minister (Mr. J. A. Lyons) has just introduced into Parliament a Financial Emergency Bill, which, amongst other things, provides for the cessation, from September 30, of the gold bounty, which is not to be restored until the London price of gold is down to £5 an ounce, and the Australian price to £5 10s. In introducing the bill Mr. Lyons explained that the Australian pound in relation to gold has depreciated so much since 1930, when the bounty was introduced, that, without any allowance for the bounty, the gold producer now receives far more for the Australian pound than was contemplated when the bounty was first provided. At that time the mint price of gold in Australian pounds was £4 4s. 11d. per fine ounce. When the bounty was reduced in July last the price was £5 9s. 1d. an ounce and at present it is £7 6s. In these circumstances the Prime Minister considers the payment of the bounty from the Commonwealth revenue cannot be justified. It is estimated that if it is suspended from September 30 the amount payable for this year will be £100,000 and that a saving of about £300,000 will be effected during the current financial year ending June, 1933.

Aerial Geological Survey.—The Geological Adviser to the Commonwealth (Dr. W. G. Woolnough) completed his survey of Australia a few days ago, when he returned to Melbourne after having flown 10,000 miles round the Australian coast and taken 2,500 photographs of promising geological formations. He states that he has covered nearly all of what he considers at present to be the oil-bearing areas of the country and that the expedition has exceeded expectations from every point of view. He emphasizes the conclusion which he has come to—as stated in a preliminary report—that it is practically certain that oil will be found in abundance in Australia.

Gold in Central Australia.—In May last Mr. R. N. W. Bligh, with three others representing a local syndicate, left Toowoomba, in Queensland, on a gold-seeking expedition to Central and North-West Australia. A few days ago he returned and has come back more than ever convinced that there is enormous mineral wealth in those regions. The country, however, was found to be very rugged and in many places almost inaccessible. The party pegged out four reefs. In the biggest reef, ore to the extent of 500 tons is in sight. The Toowoomba syndicate represented by the party holds 92 acres at Marble Bar and is to meet in a few days to decide on future action. Another party, representing a North Queensland syndicate, is about to leave Townsville to search in Central Australia for a rich gold deposit located by two brothers of the leader (Mr. Chas. Schultz), each of whom lost his life on his return journey. The deposit is said to be near Tanami, not far from the South Australian border, where another expedition recently reported having discovered rich gold deposits.

New Guinea Gold.—Mr. R. A. Archbold, of the New Guinea Goldfields Company, arrived in Brisbane recently. The prospects he said, are bright. A new field at Ramu has shown good results, although the shortage of water has been against extensive working. He mentioned that the main work at Edie Creek is pumping, in order to reach the sulphide zone, upon which depends the future of the field. At the Golden Ridges the company has three and a half years' supply of ore and another outcrop has been discovered close by. From the alluvial material it is expected to extract 3,000 oz. of gold a week. One of the few independent miners in New Guinea (Mr. E. Fahey), who has also been in Brisbane, on his way from the field to Sydney, states that there is plenty of "new" country to be exploited in the Territory, but it is all jungle and hard to get to it. Individuals, it seems, stand little chance of success. While he was working his claim Mr. Fahey, with the help of 20 natives, took out 400 oz. of gold in four months.

JOHANNESBURG

October 6.

Flattening Reefs.—In the Crown Mines 17A sub-vertical shaft the South Reef and Main Reef Leader have been intersected at depths of 5,240 and 5,360 ft. respectively some three months earlier than was anticipated owing principally to the flattening of the reefs and associated beds in that locality. The dip averages 26°, or 4° less than that of the nearest operating section of the mine at a distance of 4,000 ft. eastwards. In addition to the lesser slope along the normal direction of the dip towards the south, therefore, there is a rise in the horizon in the direction of the Consolidated Main Reef deep levels westwards. It has been pointed out that, as far as the Crown Mines property is concerned, there are still between 4,000 and 5,000 ft. to go down the incline from the 17A shaft until the southern boundary of the property is reached in that section of the mine. Since it is not unlikely that the degree of dip will continue to diminish, it is probable that the depth of mining in that locality will be considerably lessened compared with what has been expected and that a fairly large extent of workable ground will be available beyond the boundary referred to on the farm Diepkloop No. 9. If, at the same time, the rising tendency of the reef series in an easterly line along the strike, as suggested by the recent Crown Mines announcement, is maintained in the direction of the two Klipspruit properties, below the Consolidated Main Reef block and the old Vogelstruisfontein mines, it should persist in the direction of the New Steyn Estate areas. The importance of such a possibility, from which the lifting of a vast stretch of reef-bearing ground into the range of economic mining may result, will readily be appreciated. Between the 17A sub-incline shaft of the Crown Mines and the Witpoortje Fault there are nearly ten miles of country along the direction of the strike of the reef series that may be thus materially affected. It is considered that the area in which evidence of flattening, or of a low dip generally, may reasonably be looked for, and where such evidence will be of considerable value, is that of the Western Areas, Ltd., south-west of the Randfontein Estates' property, where drilling operations have been resumed after a lapse of some years. Bore-holes have been put down there to various depths up to about 3,000 ft. or more, but it does not appear that they have given any definite information with respect to the main direction of dip, nor of its average rate over the whole block. If it is eventually shown that the reefs lie at a workable depth, as well as being possessed of a reasonable percentage of payable ore, it is obvious that the information will be of no small importance not only to the Western Areas themselves, but to a wide stretch of neighbouring country.

West Springs.—An encouraging bore-hole strike has been made in the south-western portion of the West Springs mine where the formation is broken and development has hitherto been attended by disappointing results. It appears that work had been held up in No. 2 south-south-east haulage, where drilling was taking place, by a big downthrow. When the more settled formation was reached drilling was resumed. The bore-hole intersected the reef 200 ft. below the haulage and assays indicate the extremely satisfactory value of 18·7 dwt. over a true width of 34 in., or 636 in.-dwt. Another bore-hole is being put down in this area and further developments are awaited with keen interest. It has been pointed out that, quite apart from the interest which attaches to the exploratory work at West Springs, as its results affect the position of the company itself, there is the additional and greater interest which results from the fact that bore-holes have been put down in an area commonly supposed to mark the outer limits of the Far East Rand pay-stream upon its south-western edge, if not actually in country in which there is little reef of payable value. The available knowledge of this line is somewhat scanty, owing to the want of development and exploratory work upon an adequate scale. The Apex, at the north-western end, as has lately been announced, has found encouraging prospects upon further investigation, and the gap between Brakpan Mines, Ltd., and the Witpoort Areas is still considered worth examination and will be explored by the former company. The pay-shoots of the Sub-Nigel, which are trending more or less in the same direction and may extend into the unknown zone in question, are as yet insufficiently advanced to throw a conclusive light upon the matter. All such evidence, therefore, as that which is being obtained in the West Springs bore-holes and in the development which is being carried out in their vicinity, adds further knowledge of a useful and much-needed kind. Haulages and drives have been made far beyond the limits of stope areas, and upon the Brakpan Mines have explored the intervening area in the direction of the Witpoortje joint boundary in a broad preliminary way. In the West Springs and Springs Mines ground, development has extended similarly up to a line which may be drawn between the southernmost shafts of the two properties. It is roughly along the direction of this line that broken ground appears to prevail and the more favourable results obtained latterly upon that side of properties in question has led to the hope that the available unworked mining claims towards the south and south-west will disclose more settled and generally profitable conditions.

Oil Discovery.—Oil is reported to have been discovered on the farm Sandhurst, about 16 miles from Harrismith, in the Orange Free State.

Transvaal Oil-Shale. — Samples of Wakkerstroom oil-shale have been sent to England for special examination by Mr. Cunningham Craig with reference to the nomenclature that should be adopted with respect to the material from that district. It is of a different character from that of the Ermelo area, which ranges from a clean torbanite to a torbanitic cannel. A microscopic investigation of the Wakkerstroom shale shows the presence of gels and it is probable that the differences between the two types of occurrence, from the economic standpoint, are mainly dependent upon the relative percentage of these bodies.

Platinum Property Sold.—The ground held by the Platinum Exploration Co. (in voluntary liquidation) in the Lydenburg district has been purchased by a Johannesburg syndicate for £175. The property includes 50 precious-metal claims and mining leases over 500 claims.

Gold Dredging in Mozambique.—The Revue Dredging Co., Ltd., has been registered in Southern Rhodesia to acquire and operate the dredge formerly worked by the Andrada Mines on the Revue River in Mozambique territory. The dredge has been tested under option during the past year and the option holders believe that the undertaking can be made a profitable one. The dredge is being dismantled and will be erected at a more promising area of the concession.

TORONTO

October 18.

Sudbury.—International Nickel is now handling about 1,000 tons of ore a day, which represents about the lowest level in several years. Increased activity, however, is in prospect as the company anticipates increased business and is planning to re-open some of the mines now closed as soon as the demand will justify it. The company's mill capacity with its new plant is approximately 8,000 tons a day. The anticipated increase in production is mainly dependent on the demand for nickel from the steel and motor industries of the United States. Blister copper receipts at the Ontario refining plant are now confined to International Nickel's shipments. A few months ago copper was being received from Sherritt-Gordon and Consolidated Smelters, but Sherritt-Gordon closed down some time ago and Smelters has stopped its shipments. The Falconbridge curtailed operations for a time while repairs were being made to the furnaces and smelter. The deliveries of nickel in fulfilment of contracts were not affected and shipments of matte were continued on schedule. Prospecting for gold has been very active in the Swayze area, leading to further discoveries regarded as important. One of the most promising claims, known as the Kenty property, has been taken over by a new company known as the Kenty Gold Mines, Ltd., which has begun active development. A shaft is being put down to a depth of 500 ft. and some high-grade veins have been opened up. The Consolidated Mining and Smelting Company has acquired a group of 12 claims in Denyes township, surface showings on which yielded encouraging assays in gold.

Porcupine.—The gold mines of the Porcupine area during September yielded bullion to the value of $1,857,892, from the treatment of 282,127 tons of ore, as compared with the August output of $1,865,385 from 298,565 tons of ore. The mill of the Hollinger Consolidated is treating about 5,000 tons of ore per day with an average grade of $6 per ton. Production for the year to date is in excess of that of last season. Development at depth on the Schumacher section of the property has been attended with favourable results, important ore zones have been opened up, and the company is assured of sufficient ore to maintain the mill at its present rate for several years to come. A. F. Brigham, who has been manager of the mine for the past 16 years, has resigned his position, but will be retained at the mine as consulting engineer, John Knox, late assistant manager, becoming general manager. Dome Mines reports bullion production during September valued at $341,619, as against $317,788 in August. The mill is handling about 1,500 tons of ore per day with mill heads of $7·85. On the 23rd level a new find has been made which is stated to yield better than average mine values. Assays are reported to show some high value with the average around $10 per ton. Plans have been prepared for the sinking of a new shaft to be located about one mile from the main working shaft to open up a new section of the property. The McIntyre realized profits during its last fiscal year which enabled it to supplement its usual dividend of 25 cents per share by an extra 12½ cents and its account for the current year will show a substantial surplus. Preparations are being made to re-open the De Santis property a few miles south-west of Timmins. A shaft was put down some 200 ft. and two levels opened up, but work was suspended when finances were exhausted. Underground exploration will be undertaken and, if mineral conditions justify it, a 100-ton mill will be installed. The Vipond Consolidated for the three months ended September produced bullion, valued at $103,157, from 27,096 tons milled with an average recovery of $3·81 per ton, as compared with $123,400 from 26,778 tons of ore with a recovery of $4·61 per ton for the previous quarter.

Kirkland Lake.—During September the Kirkland Lake mines treated 151,253 tons of ore, which yielded $1,943,008, as compared with $1,985,125 from 150,721 tons of ore during August. The annual report of the Lake Shore for the fiscal year ending June 30 showed a bullion production of $12,356,759, as compared with $9,152,935 for the previous year. The net profits were $7,797,011, and 834,431 tons of ore were treated. Broken ore reserves amounted to 258,914 tons valued at $4,490,000. The successful operation of the cut-and-fill method of mining in the underground workings has raised the grade of ore and the improved extraction at the mill has been of material advantage. The Teck-Hughes after passing through somewhat lean horizons in its deep development campaign is stated to have encountered high-grade ore on the 40th level. Mill heads are being maintained at between $13 and $15 per ton. Mine development is proceeding, and it is expected that the next five levels to be opened up will place the mine in high-grade ore. The Wright-Hargreaves is making steady progress with its deep development programme, which includes the sinking of two shafts to a depth of 4,000 ft. Active work is being maintained on the new lower levels down to 3,000 ft. On the bottom horizon operations are being conducted through a mineral section carrying high-grade gold values, showing a strong similarity to the Lake Shore vein system. The mill is handling about 800 tons of ore a day. Sylvanite continues to meet with good results in opening up the new mineral zones on the bottom levels. Stoping is proceeding on the 2,500-ft. level. This vein on the 3,000-ft. level is broken up into two parts with low-grade values distributed between them. At the Kirkland Lake gold mine the shaft is being put down another 500 ft. from its present depth of 4,750 ft. It is believed that the opening up of lower levels may prove greater continuity of ore lengths than on the present horizon. At the Lakeland Gold Mines several good veins have been encountered on the 450th level. The shaft will be put down to 600 ft., and a mill will shortly be installed. Toburn Gold Mines, operating the old Tough Oakes Burnside property, is now established on a production basis, its September output being valued at approximately $50,000. The vein system has been picked up and is responding well to development.

Other Ontario Goldfields.—In the Patricia district the Howey gold mine during the nine months ending September 30 milled 242,700 tons of ore of an average grade of $3·65 per ton and produced bullion to the value of $856,000. After all deductions there remained a net operating profit of $355,000.

Good progress is being made with the deep development programme, and results from the two new levels at 1,175 and 1,315 ft. are encouraging. Mid-Continent Goldfields, Ltd., is planning an extensive campaign of exploration and development on a group of claims in the Red Lake area, where surface showings have disclosed free gold in several places. The Parkhill, in the Michipicoten area, has installed a new electric hoist and has resumed shaft sinking, the objective being 750 ft. Two new levels will be opened up. The International Mining Corporation is developing a group of claims in the Dog Lake area of Algoma. In a test pit which is being put down by hand steel high-grade values have been encountered. A small mining plant will be installed. The mill of the Moss mine, in the Kashabowie area, is handling about 150 tons of ore per day, with mill heads averaging $12 per ton. Underground development is steadily building up the ore reserves with a view to increasing the capacity of the mill. Preliminary arrangements are being made to resume development work on a large scale at the Horseshoe Mines in the Lake of the Woods district.

North-Western Quebec.—Noranda Mines continues its big exploration campaign, in addition to maintaining production at its former high rate. Work has been commenced on the Chadbourne ore-body on the west end of the property and is proving a large tonnage of $3 to $4 gold ore, with widths in places measuring up to 100 ft. Diamond drilling, which has been done down to about 700 ft., may be carried down more than double this distance. With the doubling of its concentrator production next January the company will be enabled to handle 2,000 tons of concentrating ore and 2,000 tons of direct smelting ore daily. The Siscoe gold mine, during the month of September, produced $69,182, as against $91,491 in August and $87,696 in September a year ago. Tonnage treated last month was 5,249, and mill heads averaged $13·46. The company is increasing its ore reserves with the object of bringing its mill capacity to 225 tons daily early next year. Underground development is being continued on a large scale and shaft sinking is proceeding at a favourable rate and it is expected that new levels down to 1,000 ft. will be established and under development before the end of October. At the Pandora Mine, in Cadillac Township, high-grade ore has been intersected, the vein being parallel to a strong vein which carries free gold. The discovery is regarded as adding considerably to the possibilities of the mine. The new mill of the Treadwell Yukon Mines in the Pascalis district is running smoothly and treating between 30 and 40 tons per day. The shaft is down 750 ft. with three levels established. Some high values have been encountered, but ore conditions are stated to be somewhat erratic. The Adanac, situated directly east of Granada, in opening up its main ore zone, encountered an intrusion of porphyry eight feet in width in contact with a shear zone 15 ft. wide, containing considerable mineralization. This discovery is now receiving attention. Hollinger Consolidated Gold Mines is maintaining operations on a large scale in the Pascalis district and, in addition to its group adjoining the Jewsey claims, has taken an option on the Hughes group in Louvicourt township and will start diamond drilling and surface exploration work immediately. Hollinger has also obtained an option on a group of claims adjoining the Croesus and is engaged in diamond drilling to determine values underground.

Manitoba.—The San Antonio gold mine, in Central Manitoba, during August produced bullion to the value of $78,000 including premium, establishing a new record. The mill heads were approximately $16 per ton, while the average mine-run ore carries between $12 and $13 per ton. Work is being carried on in ore of good commercial grade, with high-grade sections appearing at intervals. The Ore Grande Development Company is planning to erect a mill of substantial capacity on its property in the Long Lake section. The company has been operating a small test mill with encouraging results. With a good tonnage of high-grade ore in sight a much larger plant is required. Ventures, Ltd., is preparing to bring its Island Lake property into production as rapidly as possible.

VANCOUVER

October 10.

Bridge River.—The new mill at the Pioneer mine is in operation and is being worked up gradually to its full capacity. The process of treatment is that of continuous counter-current decantation and represents the results of experience that has been gained in the operation of the 100-ton plant that was erected about 2½ years ago. The latest improvements in crushing, grinding, and classification machinery are embodied in the new installation and, with the addition of a bowl classifier and increased tank area in the old mill, the two plants are running on a practically identical flow-sheet. The combined capacity is expected to exceed 300 tons per day and a recovery of 98% of the values is made. A noteworthy addition is represented by two Dorr filters after the final thickeners, by which tailing loss resulting from somewhat marked variation in the value of the mill feed is compensated largely. Heads to the mill range from $15 to $40 per ton, averaging around $20. A large proportion of the ore is being won from development and there is a large reserve of broken ore in the stopes. Cross-cutting to the main vein from the new three-compartment vertical shaft is still in progress in three out of the five new levels, the lowest, or 14th, level being at a depth of 1,625 ft. below surface. On this level a newly-discovered vein has been driven on for about 150 ft. This vein lies in the foot-wall of the main vein and was encountered first in sinking the shaft. Within the limits of development the strike of this vein appears to be slightly erratic and the dip varies also, but there are well-defined walls and it is expected that it will be responsible for a considerable tonnage. Another vein of highly promising appearance was exposed in the shaft workings near the surface. This vein lies in the hanging-wall of the main vein. The possibilities of these recent developments can be hardly estimated at the present time. It has been reported that shaft sinking is to be continued immediately to a greater depth, but it is stated on good authority that there will be no further move in this direction until definite information is available in regard to the persistence of the veins to the limits of the existing development and a considerably greater amount of work in cross-cutting and driving is needed for this purpose than has been done up to the present time. A large number of buildings has been erected on the property and more are in course of construction. A marked contrast in the treatment of Bridge River ore is to be noted in the processes adopted by Pioneer and Bralorne mines respectively. At the Bralorne mill, treating ore from the Lorne mine, the old blanket process is used and it is claimed that 75% of the recovery is made by this means. Two ball-mills are employed, crushing the rock from a jaw-breaker under a light load, and the pulp, of which no more than 50% is less than 200 mesh, is passed over five blanket tables. The blankets are washed by hand in tubs, the concentrate is further reduced in a jig and is then amalgamated in batches in a 1,000-lb. clean-up barrel. Tailing from the blankets goes through a 10-cell M.S. flotation plant. The mill is treating about 100 tons per day of ore averaging about $14 per ton, and flotation concentrate to the amount of about 3 tons per day, assaying around $115 per ton, is shipped to the Tacoma smelter at a cost of about $9 per ton. Bullion and concentrate production is valued at about $45,000 per month. It is claimed that a 94% extraction is obtained in the mill. Development on the lower levels on the King vein has been resumed and it is stated that a considerable extension of the ore shoot in the upper levels has been proved. It is reported that, since the commencement of milling operations last February, new ore reserves have exceeded extraction. There have been several rumours in regard to important discoveries on Cadwallader Creek above the Pioneer property, and claims have been advanced that extensive areas of the ore-bearing augite-diorite formation have been located. It is learned, however, that recent discoveries represent prospects of questionable importance and that the occurrence of the diorite is restricted to narrow tongues penetrating altered sedimentary and volcanic formations. It is indeed possible that, as a result of recent intensive geological investigations, there may be some modifications of the previously-held theory of the character of the ore-bearing formations of the Bridge River district. It is recognized that many facts have been brought to light by underground workings that were not available when the original geological map of the area was prepared. While in no way minimizing the importance of the developments in the Pioneer and Bralorne mines, these considerations may have a bearing upon the all-important question of the depth-persistence of the Bridge River veins and meanwhile it would appear that the value of discoveries in the area outside the two known producing properties should be assessed on their own proven merits alone. It is understood that, in spite of unprecedented activity following the recent expansion of the Pioneer and Bralorne undertakings, no new occurrences of major importance have been brought to light in the area. Bridge River Exploration

Company, Ltd., operating the properties below the Lorne group, have been engaged in laying out a town site and have installed a small portable compressor for carrying on the work of exploration on the California vein, which is said to be opening up fairly well, while a small amount of hand work is being continued on the Why Not property.

Queen Charlotte Islands.—It is stated that a sufficient tonnage of ore has been developed at the Skidegate-Sunrise property under operation by Kitsault Eagle Silver Mines, Ltd., to warrant the erection of a treatment plant and it is understood that plans for its construction will be put into effect immediately. A large amount of development work has been carried out, driving on two veins resulting in the proof of two ore-shoots from which average values are said to range between $12 and $48 per ton over distances varying between 120 and 400 ft. One vein is said to be over 12 ft. wide. The method of treating the ore has been investigated with care and it is understood that the initial treatment plant will embody both amalgamation and flotation and have a capacity of 30 tons per day. Development is being pushed ahead with the ultimate objective of increasing treatment capacity to 100 tons per day. It is reported that additional capital is forthcoming on a favourable report of an examination that has been made recently at the instance of Vancouver interests.

Portland Canal. — Good progress is reported of the developments at the property of Georgia River Gold Mines, Ltd. Cross-cutting towards the south-west vein from the Bullion tunnel workings has been advanced for the full distance of 80 ft. that was estimated as being necessary to reach the downward continuation of the vein, shown in surface workings some 270 ft. vertically above, and it is stated that the ground shows heavier mineralization, such as is found in the wall-rock bordering the veins. Samples from recent open-cut workings on the 6-ft. Summit vein are said to have assayed $11·60 per ton. A new ore zone is reported to have been discovered on the Salmon Gold property from which samples are said to assay $56 per ton in gold. Interesting accounts are received of recent discoveries of high-grade silver-lead-zinc ore on the Virginia K group of claims on American Creek. These properties were acquired in 1929 by Excelsior Prospecting Syndicate and surface work has been in progress for the past three seasons. The ore occurrence is described as being related to well-defined zones that have been traced on surface for considerable distances in which black calcareous sediments are replaced by iron, lead, zinc, and copper sulphides. The principal zone is about 20 ft. wide. Control of the group of 18 claims is now vested in Northwestern Aerial Exploration.

Lillooet.—It is reported that plans are being completed for the installation of a 50-ton mill at the Big Slide mine at the junction of Kelly Creek with the Fraser River and it is said that Seattle capital has taken an interest in the concern following a favourable report. It is stated that the vein has widened to seven feet in the winze workings from the No. 3 tunnel and that values are considerably higher than the average in the upper workings. The amount of ore that is blocked out in the upper workings is estimated at around 7,000 tons of an average value of $14 per ton.

Coast.—There has been active prospecting lately in the Kennedy Lake area of the Clayoquot district of Vancouver Island. This section has been known to prospectors for many years. In 1900 a number of narrow gold-quartz veins were being worked and a small mill was in operation. The placers of Wreck Bay are thought to have their origin in these veins. It is reported that new discoveries have been made and that a small stampede has ensued.

Phillips Arm.—Attention is being paid again to the lode-gold properties around Phillips Arm, where the Doratha Morton and Alexandria mines are situated. The continuation of the Alexandria zone is said to be traced across the bay to Thurlow Island, where there are two promising properties, the Douglas Lake and Hope groups. The latter property was under development some years ago when a cross-cut tunnel was driven for 70 ft. with the ultimate object of intersecting a vein from which high gold assays had been obtained on surface. The Hope group is owned by Thurlow Gold Mines, Ltd., of Vancouver. Underground work has indicated an ore-shoot about 300 ft. long in a vein that varies in width from two to five feet. High values in gold are obtained in places and a shipment of two tons of sorted ore from a tunnel dump is said to have yielded returns of $50 per ton.

Boundary.—The Nickel Plate mine has been reopened and is under operation by New York interests. Exploration work in search of new ore shoots has been commenced. B. W. Knowles, who, for many years, was mine superintendent for Hedley Gold Mines, Ltd., and is thoroughly familiar with all the workings, is retained by the new operators in the same capacity.

PERSONAL

J. Atkinson is leaving Siam for Sydney.
A. Bennett is returning from India.
J. Chapman Brown has returned to Germany.
H. P. Buckley is now in Siam.
W. E. Cameron has set up a consulting practice in Sydney.
Carl R. Davis is leaving for West Africa.
James A. Faull has left for Morocco.
G. S. Hepburn is home from North Africa.
Aubrey E. Horn has left for Nigeria.
R. K. McLeod has left for West Africa.
R. Mellon has left for India.
W. Murray is returning from Burma.
J. Malcolm Newman has left for Australia.
M. T. O'Regan has left for Korea.
F. G. Payne has left for New Zealand.
Enoch Perkins has left New Caledonia for New York.
A. J. Peterson has left for New Zealand.
J. Dudley Pollett is returning to Sierra Leone.
Frank Powell is home from West Africa.
R. C. Riley is leaving for India.
W. H. Rundall is leaving shortly for Colombia.
James Russell is returning from Bolivia.
J. Ernest Snelus is returning from Nigeria.
Ralph S. G. Stokes has been to Bolivia and expects to return to the Rand at the end of the year.
F. L. Thomas has left for East Africa.
R. B. Woakes is leaving shortly for India.

TRADE PARAGRAPHS

London Electric Firm, of Brighton Road, Croydon, issue a leaflet giving brief particulars of their searchlights such as may be used for the illumination of night operations in open-cast mines, quarries, and similar operations.

Fry's (London), Ltd., of 24–25, King Street, London, E. 1, issue a leaflet describing the " Enox " pocket saw supplied with 2, 3, or 4 blades and suitable for cutting some part of a casting or the plant which is inaccessible to a hack-saw frame.

Wild-Barfield Electric Furnaces, Ltd., of North Road, Holloway, London, N. 7, publish a catalogue of their electric muffle, crucible, and tube furnaces together with various accessories for use with same, such as control panels and temperature regulators.

Murex Welding Processes, Ltd., of Ferry Lane Works, Forest Road, London, E. 17, issue particulars of their training courses in electric welding, in which three separate courses of instruction suited respectively to the welding operator, the technical foreman or supervisor, and the designer are available.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, in their *Metropolitan-Vickers Gazette* for October have two articles of interest to mining men. The first deals with feeder earthing devices on switchgear for mines and the second with a choice of a motor suitable for mining service.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, point out that in a reference to themselves in last month's issue an error was made in that a brochure which they were credited with producing was in fact published by the Coil Spring Makers' Association, of which association they are themselves members.

Morse Chain Co., Ltd., of Letchworth, Herts, issue a catalogue of their chains for use in power transmission. This is a fully illustrated booklet giving full details of the sizes and shapes of chains for a variety of duties and includes particulars of some very heavy drives, notably one transmitting 5,000 h.p.

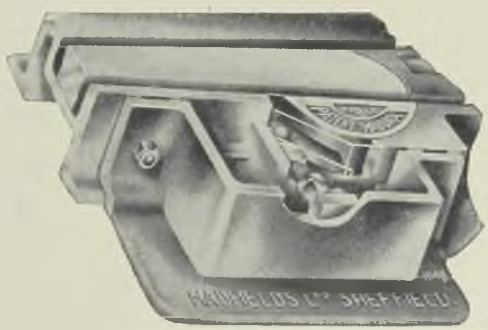
Mavor and Coulson, Ltd., of 47, Broad Street, Glasgow, were honoured this month by a visit to their works by the Duke of York. Among other things, the Duke was shown the Joy loader, already described in these columns, various coal-cutting machines, castings for electric motor parts, and forgings of picks, chain links, and other parts.

James Gordon and Co., Ltd., of Windsor House, Kingsway, London, W.C. 2, publish a leaflet describing Hagan pressure reduction and de-superheating equipment for installation in cases where modern high-pressure boilers are working in unison with low-pressure systems, which necessitates devices for reducing the high pressures and temperatures so that the steam can be used in the existing low-pressure turbines, etc.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following new orders :—For England : One 6 ft. by 48 in. Hardinge ball-mill for slack coal, and one 4 ft. by 6 ft. 1-surface type 72 Hum-mer electric screen for sand and gravel. For South Wales : One 3 ft. Raymond air separating plant for red oxide. For Australia : Two 4 ft. by 6 ft. type 70 Hum-mer electric screens for gold ore. For South America : One No. 00 Raymond pulverizer for ochres.

Fried. Krupp Grusonwerk, A.G., of Magdeburg-Buckau, Germany (London Representatives : **J. Rolland and Co.,** of Abbey House, 2, Victoria Street, S.W. 1), have issued an illustrated booklet describing their materials for crushing, grinding, and other ore-dressing machinery. This includes various classes of special steels and irons and their application in the manufacture of wearing parts for jaw and gyratory crushers, crushing rolls, hammer mills, ball-mills, drum and tube mills, and for screen plates.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, draw attention to their new improved type of tramway or light railway point, which is described as being the only point that provides a continuous bearing for the tongue for its full



length. The heel end of the tongue also has a larger bearing area than any other point on the market. There is in addition a ball adjustment at the heel end for automatically taking up wear. As usual with railway and tramway trackwork the point is manufactured in Era magnanese steel. The principle of the mechanism is clearly indicated in the accompanying illustration.

Askania-Werke A.G., of Kaiser Allee 87–88, Berlin Friedenau, Germany (London Representative: O. G. Karlowa, of Abford House, London, S.W. 1), publish a catalogue describing seismographs for geophysical prospecting. This deals with the employment of seismic methods in geology, the underlying theory of the process, the equipment required, details of the Schweydar seismograph and improvements thereon, the Schweydar geophone, and various equipments for transmitting the instant of explosion. A bibliography is included giving the principal references to the subject in media throughout the world.

Trussed Concrete Steel Co., Ltd., of 22, Cranley Gardens, London, S.W. 7, publish their Hy-Rib handbook, which is an exhaustive manual covering some 190 pages and giving full details of the application of combined centering and reinforcement to all sorts of buildings and structural work. The manual gives very complete details of the methods by which walls, ceilings, and floors are constructed with this material and there are many examples quoted, in large buildings throughout the country, of its application. In addition to exact descriptions of the steel lattice work and its method of erection for a great many purposes, specifications are included for the cement surface.

A. W. Campbell, successor to the **Chatteris Engineering Company,** of Chatteris, Cambridge, announces that the diamond concentrating pan described in an article in the previous issue of the MAGAZINE is of their design and construction. They point out also that six diamondiferous treatment plants have been supplied to the African Selection Trust, Ltd., and three to the West African Diamond Syndicate. Fourteen such plants have also been supplied to the Société Internationale Forestière et Minière du Congo and their associated company in Portuguese Angola. Similar plants have been supplied in the past to De Beers Consolidated Mines, Ltd., for various of their properties and a number of other West African, Central African, Indian, and British Guiana producers.

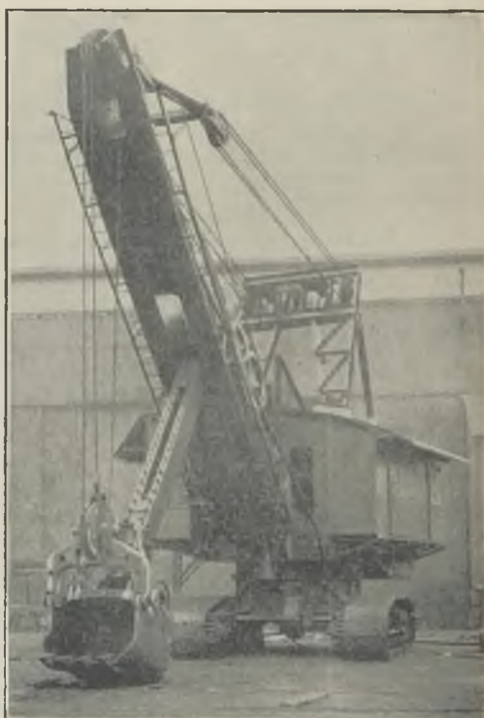
NEW RANSOMES AND RAPIER EXCAVATOR

Ransomes and Rapier, Ltd., of Ipswich, have recently constructed for the Bundi Portland Cement, Ltd., a 3/3½ cu. yd. electrically-driven excavator for digging shattered limestone. Excavators for this type of duty must be of robust construction and, following the firm's usual practice in excavator design, this machine has alloy steel cast frames throughout. The massive top frame casting weighs 13 tons and the lower frame casting weighs 12 tons, the weight of the complete machine being 120 tons. The general mechanical construction is somewhat similar to the construction of the 2 cu. yd. machine, described in the MAGAZINE for December, 1928, and further referred to in December, 1929, except that this larger machine has a live roller path and a steel boom with a composite steel and timber bucket handle.

This all-electric machine has the Ward Leonard system of control, each main motion having its own motor and each motor being supplied with current from its own generator, to which it is permanently in electrical connexion. The three generators are driven as one unit by a high-voltage induction motor (3,300 volts) running at 1,450 r.p.m., this motor being started by an automatic, push-button controlled, autotransformer starter. The whole unit is mounted on a single base plate bolted down on the three-point suspension principle, one of the fixings being spring loaded and spherically seated to ensure that no misalignment of the generator units can possibly occur.

Each generator has three field windings, a separately excited shunt, a self-excited shunt, and a differential series, all of which combine to give a characteristic varying from maximum current at zero voltage to maximum voltage at zero current. The separately-excited d.c. shunt motors supplied from these generators therefore give a variable torque-speed curve of the type so desirable for excavator service, high torque at low speed and high speed at low torque.

Control is by switching on the separately-excited shunt field to the appropriate generator, by means of a field controller, the motor fields being already excited. Full electrical control of each motion is obtained, running in either direction, braking to standstill, etc., in this way saving wear and tear of mechanical brakes. On the hoist motion the bucket is raised by pulling the controller toward the



RANSOMES AND RAPIER 3/3½ CU. YD. ELECTRIC EXCAVATOR.

operator. When the required height is reached the controller is returned to the "off" position and the bucket held in mid air by the mechanical brake. When lowering is required, the controller is pushed forward and in this position the motor drives the gears, barrel, etc., in a downward direction assisting the bucket to gain speed until the maximum lowering speed is attained, after which, with no further movement of the controller, the bucket lowers at this maximum speed but cannot exceed it. To bring the bucket to rest finally the controller is reversed, i.e. brought toward the operator, this stopping the bucket without the aid of the mechanical brake. The braking energy is regenerated and returned to the supply line, thus reducing the power consumption. The other motions operate in a similar manner. Air supply for the mechanical brakes and the main clutch is provided by a single-stage, two-cylinder, water-cooled compressor arranged to start and stop automatically when pressure is down to or up to the permissible limits.

Each main motor is forced ventilated, a small electrically-driven blower being mounted on the motor frame, giving a constant supply of cooling air. In this manner the usual risk of burning out the electric motors through abuse is largely overcome and the motors can safely perform the severest excavator duty. This feature will appeal to operators in tropical countries. Both the main induction motor and the main hoist motor are continuously rated, respectively at 200 and 100 h.p. The electric equipment referred to in the foregoing was manufactured by the **British Thomson Houston Co., Ltd.,** of Rugby.

METAL MARKETS

Copper.—Business in the Standard market in London was dull throughout October, and despite the weak sterling exchange, which should have tended to maintain values, prices lost a fair amount of ground. Electrolytic was easy and fell from 5·75 cents per lb. f.a.s. New York to 5·00 cents. Interest now centres on the proposed British import duty and on the meeting of copper producers which is to follow the imposition of that duty in an endeavour to maintain the existing output-curtailment agreement and to allot markets. The future is very obscure, but the copper industry is certainly in an unenviable plight.

Average price of Cash Standard Copper: October, 1932, £31 18s. 7d.; September, 1932, £35 0s. 7d.; October, 1931, £35 0s. 1d.; September, 1931, £31 11s. 1d.

Tin.—Steady conditions ruled during October. At times industrial buying was quite good, whilst both actual and potential support from "Pool" quarters was in evidence. The October statistics turned out to be rather disappointing, however, showing a very small reduction in the world supplies in sight over the month, and unless the rate of diminution accelerates the working-off of surplus stocks will take a tremendous time. The American tinplate industry—one of the most important consumers—is now operating at a fairly satisfactory rate, everything considered, but American deliveries of tin remained restricted during October.

Average price of Cash Standard Tin: October, 1932, £151 7s. 6d.; September, 1932, £152 16s. 3d.; October, 1931, £127 0s. 9d.; September, 1931, £117 17s. 10d.

Lead.—This was a dull market last month, demand being quiet, whilst sentiment was overshadowed by the knowledge that world stocks are of unwieldly dimensions, amounting to around 450,000 tons. Holders are able to put up a pretty fair resistance to "bear" influences, but obviously general conditions are not in their favour. The price, however, is getting pretty low, and this should normally attract increased attention.

Average mean price of soft foreign lead: October, 1932, £12 1s. 3d.; September, 1932, £13 4s. 8d.; October, 1931, £13 4s. 11d.; September, 1931, £11 19s. 6d.

Spelter.—At one time the market seemed to be trending easier, but it manifested a stronger tone subsequently, partly, of course, owing to the weak aspect of sterling, so that prices closed the month of October practically unchanged. It is generally admitted that spelter is the best of the non-ferrous markets from a statistical point of view, but it is handicapped like so many other commodities by an unsatisfactory industrial demand.

Average mean price of spelter: October, 1932, £15 0s. 1d.; September, 1932, £15 10s. 8d.; October, 1931, £12 19s. 5d.; September, 1931, £11 16s. 4d.

Iron and Steel.—There are slight signs of an improving tendency in the British pig-iron market, but the general situation at the blast furnaces cannot be described yet as at all satisfactory. Cleveland makers continue to adhere to their minima for local deliveries, No. 3 foundry g.m.b. being priced at 58s. 6d. Makers are ready to accept considerably less for Scotland, in which market, incidentally, heavy arrivals of Indian pig-iron seem to have given the local furnaces the *coup de grace*. In finished steel improvement is very slow to manifest itself, although the further depreciation in sterling ought to help in protecting the British mills from foreign competition. The decision of the British authorities to continue the existing import duties on foreign steel for a further two years at the previous rates has cleared up a matter of considerable uncertainty, which was troubling the market and, whilst the British works seem fairly content with the decision, Continental makers admit that things might have been worse. The instability of sterling has made it difficult for Continental works to place material in this country, but elsewhere they report a very good demand and the Continental steel market is in a more favourable condition than for a long time past, the mills having booked a considerable amount of business and prices having been advanced quite substantially from the previous ruinous levels.

Iron Ore.—In this country works have bought a few odd lots, occasionally at very low prices, but on the whole business has continued poor. The depreciation in sterling has tended to raise values, best Bilbao rubio now being fully 14s. 6d. per ton c.i.f.

Antimony.—Demand continued very slow during the early weeks of October, but Chinese shippers maintained a fairly firm attitude. When cheaper second-hand parcels were absorbed values rose, metal for forward shipment from China now being about £26 c.i.f., with spot fully £27 ex warehouse. English regulus is quoted at £35 to £42 10s.

Arsenic.—Continental competition resulted in lower prices being accepted, but towards the end of

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.		Electrolytic	Best Selected.				Soft Foreign.	English.	Cash.	Forward.	
	Cash.	3 Months.			Cash.	3 Months.						
Oct.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
12	32 10 0	32 13 9	36 15 0	—	151 11 3	152 13 9	14 17 6	12 2 6	13 15 0	17¾	17 13/16	119 9
13	32 3 1½	32 6 10½	36 10 0	—	151 8 9	152 13 9	14 15 0	11 18 9	13 15 0	17 13/16	17⅞	119 10
14	31 10 7½	31 13 1½	36 5 0	33 15 0	149 17 6	150 18 9	14 7 6	11 13 9	13 10 0	17 11/16	17 13/16	119 9
17	31 16 10½	32 0 7½	36 10 0	—	151 11 3	152 3 9	14 10 0	11 15 0	13 10 0	17 11/16	17¾	119 10
18	31 13 9	31 16 10½	36 10 0	34 0 0	153 1 3	153 8 9	14 10 0	11 11 3	13 5 0	17¾	17 13/16	120 0
19	32 7 6	32 10 7½	37 0 0	—	153 3 9	153 8 9	14 18 9	11 18 9	13 15 0	17⅞	18	122 2
20	32 1 3	32 5 7½	36 10 0	—	152 0 0	152 8 9	14 17 6	11 15 0	13 10 0	17⅞	18	121 10½
21	31 15 7½	32 0 7½	36 5 0	34 5 0	151 17 6	152 2 6	14 17 6	11 16 3	13 10 0	17¾	17 13/16	121 7
24	31 8 9	31 11 3	36 0 0	—	151 7 6	151 15 0	14 17 6	11 15 0	13 10 0	18	18 1/16	122 11½
25	31 11 10½	31 14 4½	36 0 0	33 15 0	153 11 3	153 17 6	15 3 9	11 18 9	13 15 0	18	18⅛	125 4½
26	30 13 1½	30 15 7½	35 10 0	—	152 3 9	152 12 6	15 1 3	11 12 6	13 10 0	17¾	17⅞	124 3
27	30 12 6	30 15 7½	35 10 0	—	153 0 0	153 12 6	15 1 3	11 12 6	13 10 0	18⅛	18 3/16	125 8
28	30 11 3	30 15 0	35 10 0	32 15 0	153 0 0	153 13 9	15 2 6	11 15 0	13 10 0	17 15/16	18 1/16	125 8
31	30 5 7½	30 9 4½	35 10 0	—	152 12 6	153 8 9	15 2 6	11 16 3	13 10 0	18⅛	18¼	125 5
Nov.												
1	30 5 7½	30 9 4½	35 10 0	32 15 0	152 7 6	153 0 0	15 1 3	11 17 6	13 10 0	18 3/16	18¼	125 5½
2	29 19 4½	30 3 9	35 0 0	—	152 3 9	152 18 9	15 2 6	11 13 9	13 10 0	18 1/16	18 3/16	124 3
3	30 5 7½	30 8 1½	35 0 0	—	152 6 3	153 2 6	15 1 3	11 15 0	13 10 0	18⅛	18¼	125 4
4	30 5 7½	30 9 4½	35 0 0	32 15 0	152 3 9	152 18 9	15 2 6	11 17 6	13 10 0	18 3/16	18 5/16	125 6½
7	31 13 9	31 17 6	35 15 0	—	153 6 3	153 18 9	15 5 0	12 2 6	13 10 0	18¼	18⅜	124 9½
8	33 3 9	33 7 6	37 0 0	35 10 0	155 7 6	156 2 6	15 10 0	12 8 9	14 0 0	18⅜	18½	124 8
9	32 18 9	33 3 1½	37 15 0	—	155 13 9	156 2 6	15 8 9	12 11 3	14 0 0	18¼	18½	124 8½
10	32 6 10½	32 10 7½	37 15 0	—	154 12 6	155 2 6	15 7 6	12 8 9	14 0 0	18 3/16	18 5/16	125 4

the month exchange considerations occasioned a small recovery. On balance, however, prices are lower, Mexican being obtainable at about £21 10s. to £22 c.i.f. Cornish white is now about £22 f.o.r. mines.

Bismuth.—Owing to the depreciation in sterling, prices have been advanced to 4s. 9d. per lb. for 5 cwt. lots and over.

Cadmium.—Dull conditions rule in this market, but quotations are steady at 1s. 8½d. to 1s. 9d. per lb.

Cobalt Metal.—Leading interests continue to quote officially 7s. per lb. although demand is slow.

Cobalt Oxides.—Prices are firmer, although sales continue small. Somewhere about 5s. per lb. is named for black and 5s. 6d. for grey.

Chromium.—A quiet but steady business is passing at about 2s. 9d. per lb. delivered.

Tantalum.—Very little is changing hands, but prices remain at £15 to £20 per lb.

Platinum.—Demand has been very poor but, with the depreciation in sterling, quotations were advanced to the present level of £9 to £9 10s. per oz. for refined metal.

Palladium.—About £4 to £4 4s. per oz. is still quoted for this metal, business being slow.

Iridium.—Little interest is shown, but quotations are nominally unchanged at £12 to £14 per oz. for sponge and powder.

Osmium.—About £11 10s. to £12 10s. per oz. is named for this metal.

Tellurium.—The market is virtually idle, but prices are nominally unchanged at about 20s. per lb.

Selenium.—High grade black powder is still quoted at 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

Manganese Ore.—Little new business has been done, and although at one time a few inquiries were about for 1932 delivery, these came to nothing. Prices are steady at around 9½d. per unit c.i.f. for best Indian, and 8½d. to 9d. c.i.f. for 50 to 52% Caucasian washed.

Aluminium.—There has not been any improvement in the demand for raw aluminium since prices were raised to their present level of £100, less 2% delivered, for ingots and bars ; and the general tone of the market is quiet.

Sulphate of Copper.—English material is quoted at about £17 10s. to £18 per ton. f.o.r., less 5%.

Nickel.—The price has been advanced to £250 to £255 per ton, on account of the depreciation in sterling. Demand continues light.

Chrome Ore.—A little more business has been moving recently, but prices are quotably unchanged at 80s. to 85s. per ton c.i.f. for good 48% Rhodesian ores, 92s. 6d. to 97s. 6d. for 52 to 54% Baluchistan, and 100s. to 110s. c.i.f. for 55 to 57% New Caledonian.

Quicksilver.—Business remains on a distinctly limited scale, but sellers are firm in their ideas, spot metal now being quoted at about £10 17s. 6d. per bottle, net.

Tungsten Ore.—After a prolonged period of inactivity demand recently has been on a rather better scale, but prices are still none too firm, forward shipment from China being offered at about 11s. 3d. per unit c.i.f.

Molybdenum Ore.—New business is trifling, but prices are well held at about 42s. 6d. per unit of metal c.i.f.

Graphite.—The market is quietly steady with good 85 to 90% raw Madagascar flake about £17 to £19 c.i.f., and 90% Ceylon lumps £15 to £17 c.i.f.

Silver.—Generally speaking, quiet conditions ruled during October. On October 1 spot bars were 17 1/16d. and, with only a little Continental selling and some trifling purchases by India, quotations kept fairly steady, being 17 1/16d. on October 15. In the second half of the month India was inclined to resell, whilst China and America worked both ways. With the renewed depreciation in sterling, silver prices advanced, but not proportionately with the decline in the exchange. On October 31 spot bars closed at 18⅛d. per oz.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
October, 1931	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012
March	914,017	46,018	960,035
April	901,894	47,902	949,796
May	919,223	46,421	965,644
June	913,297	45,714	959,011
July	933,947	47,213	981,160
August	943,174	48,148	991,322
September	912,870	48,631	961,501
October	926,686	48,279	974,965

TRANSVAAL GOLD OUTPUTS.

	September.		October.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	110,500	£154,796	109,000	£158,013
City Deep	83,000	21,459	81,000	21,233
Cons. Main Reef	70,500	24,017	74,000	24,745
Crown Mines	279,000	88,520	285,000	89,775
Daggafontein	44,000	£70,203	44,200	£73,212
D'rb'n Roodepoort Deep	49,000	15,499	52,000	15,985
East Geduld	61,500	20,030	63,300	20,627
East Rand P.M.	158,000	41,675	162,000	42,613
Geduld	84,000	26,796	86,600	27,743
Geldenhuis Deep	76,000	17,427	79,600	17,703
Glynn's Lydenburg	7,200	2,657	7,400	2,684
Government G.M. Areas	207,000	£406,414	208,000	£405,451
Kleinfontein	50,500	10,515	52,500	10,102
Langlaagte Estate	82,000	£106,066	78,000	£104,088
Luipaard's Vlei	34,500	8,656	35,100	37,211
Meyer and Charlton	—	—	—	—
Modderfontein New	174,000	62,982	176,000	62,931
Modderfontein B	76,000	21,262	78,000	21,745
Modderfontein Deep	44,800	21,529	44,600	21,519
Modderfontein East	76,000	22,319	76,000	22,310
New State Areas	89,000	£180,586	87,000	£181,211
Nourse	71,000	21,078	72,000	21,200
Randfontein	240,000	£293,877	250,000	£300,914
Robinson Deep	98,400	28,453	98,500	28,369
Rose Deep	61,000	12,888	62,800	12,476
Simmer and Jack	68,500	18,932	81,300	22,466
Springs	77,500	£160,873	79,600	£162,586
Sub Nigel	36,200	33,163	37,300	33,468
Transvaal G.M. Estates	18,500	5,548	19,100	5,588
Van Ryn	50,000	£46,737	51,500	£47,934
Van Ryn Deep	71,000	£92,099	71,000	£93,217
West Rand Consolidated	93,500	£105,483	96,500	£106,220
West Springs	80,000	£78,880	77,500	£78,496
Witw'tersr'nd (Knights)	70,000	£54,504	72,000	£56,972
Witwatersrand Deep	48,700	15,492	46,100	15,028

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.	£
July, 1931	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	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	2,964,100	27 6	19 2	8 4	1,228,198
June	2,927,200	27 9	19 3	8 6	1,241,392
July	2,993,600	27 5	19 0	8 5	1,260,744
August	3,027,700	27 6	19 1	8 5	1,277,923
September				—	1,234,584

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
October 31, 1931	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910
July 31	217,525	12,056	—	229,581
August 31	217,658	11,727	—	229,385
September 30	216,398	11,642	—	228,040
October 31	216,2[illegible]8	11,353	—	227,651

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	46,487
May	48,189	47,645	43,731	46,854
June	48,406	45,208	44,118	48,441
July	46,369	45,810	44,765	47,331
August	46,473	46,152	43,292	49,254
September	45,025	46,151	42,846	50,198
October	46,923	45,006	44,260	—
November	46,219	44,351	44,516	—
December	46,829	46,485	50,034	—

RHODESIAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,400	9,619	25,400	9,618
Globe and Phœnix	6,054	6,362	6,102	6,258
Lonely Reef	8,800	2,296	9,400	2,239
Luiri Gold	—	—	—	—
Rezende	6,500	2,556	6,500	2,569
Sherwood Star	4,800	£8,129	4,800	£7,971
Wanderer Consolidated	14,800	3,388	15,700	3,511

WEST AFRICAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	6,211	£18,083	7,095	£21,768
Ashanti Goldfields	13,374	14,617	13,412	14,719
Taquah and Abosso	10,350	3,457	10,474	3,145

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
October, 1931	52,741	7,838*	1,031
November	53,869	4,758	1,428
December	49,215	4,700	1,224
January, 1932	44,037	—	916
February	44,672	—	981
March	47,108	9,735†	769
April	48,936	3,912	1,216
May	53,928	2,782	692
June	50,079	—	920
July	53,585	2,530	1,391
August	51,536	—	1,026
September	54,427	—	—
October	—	—	—

* Sept. and Oct. † Jan., Feb., and March.

AUSTRALASIAN GOLD OUTPUTS.

	September.		October.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,168	5,358	5,082	6,257
Blackwater (N.Z.)	3,605	2,015*	3,652	2,019*
Boulder Persev'ce (W.A.)	7,701	14,274	10,107	18,452
Grt. Boulder Pro. (W.A.)	6,968	22,636	7,604	5,513*
Lake View & Star (W.A.)	29,936	38,720	31,576	42,062
Sons of Gwalia (W.A.)	12,554	16,092	11,050	15,559
South Kalgurli (W.A.)	9,447	15,727	10,128	15,099
Waihi (N.Z.)	18,538‡	6,045* 38,519†	—	—
Wiluna	28,339	47,071		

* Oz. gold. † Oz. silver. ‡ To Sept. 17.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	September.		October.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Balaghat	—	655	—	—
Champion Reef	9,060	5,625	9,340	5,675
Mysore	14,350	7,339	14,903	7,722
Nundydroog	15,000	9,079*	15,315	8,714†
Ooregum	12,500	4,364	12,020	4,343

* 1,650 oz. from 1,521 tons Balaghat ore. † 1,501 oz. from 1,872 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	September.		October.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	56,916d†	—	—
Chosen Corp. (Korea)	10,260	14,653	10,290	15,062
Frontino Gold (C'lbia)	3,160	16,641	3,460	14,312
Fresnillo	77,687	5,187d‡	—	—
New Goldfields of Venezuela	9,036	2,230*	9,047	2,478*
Oriental Cons. (Korea)	15,647	66,304d	—	74,260d
St. John del Rey (Brazil)	—	37,200	—	39,000
Santa Gertrudis (Mexico)	22,046	25,091d	20,448	10,478d
Viborita	—	2,274	—	—
West Mexican Mines	—	—	—	—

d Dollars. * Oz. gold. † To Oct. 9. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 72% of Concentrate shipped to Smelters. Long Tons.

January, 1932	3,014	July, 1932	1,437
February	2,132	August	1,164
March	3,064	September	1,123
April	3,333	October	2,075
May	2,276	November	—
June	2,491	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.
In Long Tons of Concentrate.

	August.	Sept.	Oct.
Ayer Hitam	—	32¾	107½
Batu Caves	—	—	—
Changkat	—	20	40
Gopeng	—	24½	—
Hongkong Tin	—	31½	29¾
Idris Hydraulic	—	12	17¾
Ipoh	—	26½	87½
Kampar Malaya	—	—	—
Kampong Lanjut	25	—	—
Kamunting	—	113	156
Kent (F.M.S.)	—	—	—
Killinghall	33½	32	52¼
Kinta	—	11½	—
Kinta Kellas	—	—	—
Kramat Tin	75	80	35
Kuala Kampar	—	—	—
Kundang	—	—	—
Labat	—	11	16
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	48	52½	59½
Malim Nawar	28	30	10
Pahang	78	78	78
Penawat	—	42	73½
Pengkalen	—	22½	—
Petaling	—	90	222
Rahman	—	—	—
Rambutan	—	4½	—
Rantau	—	—	—
Rawang	30	33	50
Rawang Concessions	60	25	16
Renong	—	7¾	18½
Selayang	—	—	12¼
Southern Kampar	—	53½	94
Southern Malayan	46	51½	50½
Southern Perak	—	19¼	57½
Southern Tronoh	—	17½	17½
Sungei Besi	—	—	—
Sungei Kinta	—	24	—
Sungei Way	—	38½	35¾
Taiping	—	—	—
Tanjong	—	11½	—
Tekka	—	39*	—
Tekka Taiping	—	22	—
Temoh	—	—	—
Tronoh	—	38½	38½
Ulu Klang	—	—	—

* 3 months to Sept. 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.
In Long Tons of Concentrate.

	August.	Sept.	Oct.
Anglo-Nigerian	12¾	17⅛	14½
Associated Tin Mines	108½	107½	109½
Baba River	—	1	1
Batura Monguna	—	—	—
Bisichi	17	16	—
Daffo	—	—	—
Ex-Lands	—	23½	26
Filani	—	—	—
Jantar	10	9	12
Jos	7¾	7¾	—
Juga Valley	5	5½	5½
Kaduna Syndicate	13	11¾	—
Kaduna Prospectors	7	5¾	—
Kassa	8	5	5
London Tin	77	76	77
Lower Bisichi	5½	—	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	5	4
Offin River	—	—	—
Ribon Valley	10	9	11½
Tin Fields	—	—	—
United Tin Areas	12	10	10½
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.
In Long Tons of Concentrate.

	August.	Sept.	Oct.
Anglo-Burma (Burma)	48	47	45
Aramayo Mines (Bolivia)	114	129	123
Bangrin (Siam)	38¾	36½	77½
Beralt	26½*	26½*	—
Consolidated Tin Mines (Burma)	150	140	116
East Pool (Cornwall)	36	41½	43¾
Fabulosa (Bolivia)	38	32	41
Kagera (Uganda)	25	25	—
Kamra	—	—	—
Malaysiam Tin	14½	14½	14½
Mawchi	198*	208*	—
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	152½	170½	164¾
South Crofty	55½	53¾	54
Tavoy Tin (Burma)	97¾	69	52½
Tongkah Harbour (Siam)	45	40	36
Toyo (Japan)	75	59½	54
Zaaiplaats	—	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Sept.	Oct.
Britannia Lead	Tons refined lead	2,618	—
	Oz. refined silver	274,070	—
Broken Hill South	Tons lead conc.	5,612	5,137
	Tons zinc conc.	6,286	5,688
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	480,634	508,208
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	383	400
	Tons yellow metal	507	513
Messina	Tons copper	669	734
Mount Isa	Tons lead bullion	4,406	—
Mount Lyell	Tons concentrates	3,280†	6,285*
North Broken Hill	Tons lead conc.	2,840	4,210
	Tons zinc conc.	2,870	4,340
Rhodesia Broken Hill	Tons V_2O_5	30	30
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	3,017	3,196
Sulphide Corporation	Tons lead conc.	1,669	—
	Tons zinc conc.	2,414	—
Trepca	Tons lead conc.	4,795	5,222
	Tons zinc conc.	7,863	7,587
Zinc Corporation	Tons lead conc.	5,842	5,820
	Tons zinc conc.	4,372	4,068

* Eight weeks to Nov. 2. † To Sept. 3.

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

		August.	Sept.
Iron Ore	Tons	101,434	102,906
Manganese Ore	Tons	9,630	1,492
Iron and Steel	Tons	105,072	107,108
Copper and Iron Pyrites	Tons	34,729	12,000
Copper Ore, Matte, and Prec.	Tons	961	969
Copper Metal	Tons	18,731	17,717
Tin Concentrate	Tons	4,926	1,819
Tin Metal	Tons	120	190
Lead Pig and Sheet	Tons	21,997	15,891
Zinc (Spelter)	Tons	2,674	5,374
Zinc Sheets, etc.	Tons	1,298	1,816
Zinc Oxide	Tons	670	52
Zinc Ore	Tons	4,395	2,089
Aluminium	Tons	1,823	215
Mercury	Lb.	192,925	88,159
White Lead	Cwt.	4,417	7,023
Barytes, ground	Cwt.	14,133	26,756
Asbestos	Tons	1,023	1,985
Boron Minerals	Tons	739	1,283
Borax	Cwt.	8,741	8,608
Basic Slag	Tons	400	—
Superphosphates	Tons	3,687	1,537
Phosphate of Lime	Tons	41,892	31,682
Mica	Tons	118	124
Tungsten Ores	Tons	471	395
Sulphur	Tons	5,455	6,493
Nitrate of Soda	Cwt.	10,085	29,817
Potash Salts	Cwt.	494,013	530,225
Petroleum: Crude	Gallons	32,598,083	38,353,144
Lamp Oil	Gallons	15,306,089	17,470,320
Motor Spirit	Gallons	103,769,067	74,807,532
Lubricating Oil	Gallons	5,479,627	6,187,380
Gas Oil	Gallons	6,483,496	7,038,319
Fuel Oil	Gallons	55,332,331	29,964,904
Asphalt and Bitumen	Tons	14,103	5,100
Paraffin Wax	Cwt.	63,900	74,908

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	August.	Sept.	Oct.
Anglo-Ecuadorian	16,226	15,578	16,021
Apex Trinidad	48,230	48,650	50,750
Attock	1,543	1,397	1,523
British Burmah	3,798	3,662	3,724
British Controlled	43,019	40,171	38,691
Kern Mex	852	834	836
Kern River (Cal.)	2,518	2,275	2,891
Kern Romana	93	82	92
Kern Trinidad	1,703	1,545	1,810
Lobitos	25,013	23,912	24,803
Phœnix	97,900	105,139	106,949
St. Helen's Petroleum	4,770	4,678	4,127
Steaua Romana	103,504	108,507	114,295
Tampico	2,391	2,352	2,352
Tocuyo	1,161	1,230	1,221
Trinidad Leaseholds	27,600	28,600	28,000

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Oct. 11, 1932. £ s. d.	Nov. 10, 1932. £ s. d.
Anglo-Ecuadorian	10 9	10 6
Anglo-Egyptian B	1 15 0	1 12 6
Anglo-Persian 1st Pref.	1 9 6	1 9 6
„ „ Ord.	2 11 9	2 7 6
Apex Trinidad (5s.)	1 0 6	1 0 9
Attock	10 6	10 6
British Burmah (8s.)	4 6	4 6
British Controlled ($5)	4 0	4 0
Burmah Oil	3 5 0	3 4 3
Kern River Cal. (10s.)	2 9	2 3
Lobitos, Peru	1 18 9	1 18 9
Mexican Eagle, Ord. (4 pesos)	7 9	7 3
„ „ 8% Pref. (4 pesos)	7 6	7 0
Phœnix, Roumanian	11 9	11 6
Royal Dutch (100 fl.)	17 12 6	17 15 0
Shell Transport, Ord.	2 9 0	2 7 6
„ „ 5% Pref. (£10)	11 10 0	11 12 6
Steaua Romana	8 9	9 0
Trinidad Leaseholds	2 11 9	2 13 9
United British of Trinidad (6s. 8d.)	4 6	4 6
V.O.C. Holding	1 11 3	1 13 0

PRICES OF CHEMICALS. Nov. 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 16 5
„ „ 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.	„	5 5 0
Antimony, Tartar Emetic, 43/44%	per lb.	10
„ Sulphide, golden	„	9
Arsenic, White (foreign)	per ton	20 0 0
Barium, Carbonate (native), 94%	„	4 10 0
„ Chloride	„	10 10 0
Barytes	„	8 5 0
Benzol, standard motor	per gal.	1 6½
Bleaching Powder, 35% Cl.	per ton	8 15 0
Borax	„	16 10 0
Boric Acid	„	26 10 0
Calcium Chloride, solid, 70/75%	„	5 15 0
Carbolic Acid, crude 60's	per gal.	1 10
„ „ crystallized, 40°	per lb.	6¾
Carbon Disulphide	per ton	30 0 0
Citric Acid	per lb.	10½
Copper Sulphate	per ton	16 5 0
Creosote Oil (f.o.b. in Bulk)	per gal.	4½
Cresylic Acid, 98–100%	„	1 3
Hydrofluoric Acid, 59/60%	per lb.	6
Iodine Resub. B.P. (28 lb. lots)	„	15 5
Iron, Nitrate 80° Tw.	per ton	6 0 0
„ Sulphate	„	1 15 0
Lead, Acetate, white	„	31 0 0
„ Nitrate (ton lots)	„	27 10 0
„ Oxide, Litharge	„	29 10 0
„ White	„	39 10 0
Lime, Acetate, brown	„	8 10 0
„ „ grey, 80%	„	11 0 0
Magnesite, Calcined	„	8 5 0
Magnesium Chloride	„	6 10 0
„ Sulphate, comml.	„	4 10 0
Methylated Spirit Industrial 61 O.P.	per gal.	2 0
Nitric Acid, 80° Tw.	per ton	19 0 0
Oxalic Acid	per cwt.	2 8 9
Phosphoric Acid. (Conc. 1·750)	per lb.	10
Pine Oil	per cwt.	2 7 6
Potassium Bichromate	per lb.	5
„ Carbonate, 96/98%	per ton	32 0 0
„ Chlorate	per lb.	4
„ Chloride, 80%	per ton	9 10 0
„ Ethyl Xanthate	per 100 kilos	7 0 0
„ Hydrate (Caustic) 88/90%	per ton	39 0 0
„ Nitrate	„	30 0 0
„ Permanganate	per lb.	8¼
„ Prussiate, Yellow	„	8
„ „ Red	„	2 0
„ Sulphate, 90%	per ton	10 10 0
Sodium Acetate	„	20 10 0
„ Arsenate, 45%	„	23 0 0
„ Bicarbonate	„	10 10 0
„ Bichromate	per lb.	4
„ Carbonate (Soda Ash), 58%	per ton	6 0 0
„ „ (Crystals)	„	5 5 0
„ Chlorate	„	28 10 0
„ Cyanide, 100% NaCN basis	per lb.	8
„ Ethyl Xanthate	per 100 kilos	6 12 6
„ Hydrate, 76%	per ton	14 0 0
„ Hyposulphite, comml.	„	9 2 6
„ Nitrate (ordinary)	„	8 10 0
„ Phosphate, comml.	„	12 0 0
„ Prussiate	per lb.	5
„ Silicate	per ton	9 10 0
„ „ (liquid, 140° Tw.)	„	8 10 0
„ Sulphate (Glauber's Salt)	„	2 15 0
„ „ (Salt-Cake)	„	3 1 0
„ Sulphide, Conc., 60/65%	„	10 15 0
„ Sulphite, pure	per cwt.	14 0
Sulphur, Flowers	per ton	10 0 0
„ Roll	„	10 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 4 0
Tartaric Acid	per lb.	10¼
Turpentine	per ton	64 0 0
Tin Crystals	per lb.	1 0
Titanous Chloride	„	10½
Zinc Chloride	per ton	9 10 0
„ Dust, 90/92%	„	20 0 0
„ Oxide (White Seal)	„	35 0 0
„ Sulphate		9 0 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
SOUTH AFRICA:		
Brakpan	4 5 6	4 15 0
City Deep	10 0	13 9
Consolidated Main Reef	1 6 0	1 11 9
Crown Mines (10s.)	6 1 3	6 10 9
Daggafontein	3 1 3	3 7 6
Durban Roodepoort Deep (10s.)	1 3 6	1 3 0
East Geduld	4 1 0	4 8 9
East Rand Proprietary (10s.)	15 3	15 3
Geduld	4 18 0	5 8 9
Geldhenhuis Deep	11 9	12 6
Glynn's Lydenburg	11 3	12 6
Government Gold Mining Areas (5s.	1 16 3	1 19 3
Grootvlei	1 10 0	1 13 0
Langlaagte Estate	1 0 0	1 3 0
Luipaard's Vlei (2s.)	—	5 6
Modderfontein, New (10s.)	2 6 3	2 8 9
Modderfontein B (5s.)	12 0	13 3
Modderfontein Deep (5s.)	15 9	17 0
Modderfontein East	2 3 9	2 5 0
New Kleinfontein	—	1 2 6
New State Areas	3 0 0	3 7 6
Nourse	18 3	19 0
Randfontein	2 2 0	2 5 3
Robinson Deep A (1s.)	14 6	15 0
,, B (7s. 6d.)	14 3	15 0
Rose Deep	7 3	8 3
Simmer and Jack (2s. 6d.)	4 3	4 3
Springs	4 12 0	4 16 3
Sub Nigel (10s.)	5 17 6	6 6 9
Van Ryn	13 9	14 0
Van Ryn Deep	1 3 0	1 3 9
Village Deep (9s. 6d.)	1 6	1 6
West Rand Consolidated (10s.)	17 9	18 3
West Springs	1 6 6	1 7 6
Witwatersrand (Knights)	10 0	10 0
Witwatersrand Deep	7 9	10 0
RHODESIA:		
Cam and Motor	2 8 0	2 11 9
Globe and Phœnix (5s.)	16 6	18 0
Lonely Reef	15 0	15 0
Luiri Gold (5s.)	2 6	2 6
Rezende (17s. 6d.)	1 10 0	1 15 0
Sherwood Starr (5s.)	17 6	18 0
Wanderer	—	18 9
GOLD COAST:		
Ariston (2s. 6d.)	6 3	7 9
Ashanti (4s.)	1 17 0	1 18 6
Taquah and Abosso (4s.)	8 0	9 6
AUSTRALASIA:		
Associated Gold (4s.), W.A.	—	3 3
Golden Horseshoe (3s.), W.A.	4 3	4 3
Great Boulder Propriet'y (2s.), W.A.	7 6	7 9
Lake View and Star (4s.), W.A.	15 6	16 9
Sons of Gwalia (10s.), W.A.	12 3	15 6
South Kalgurli (10s.), W.A.	1 0 6	1 4 3
Waihi (5s.), N.Z.	16 0	18 6
Wiluna Gold, W.A.	2 2 9	2 7 6
INDIA:		
Champion Reef (10s.)	19 6	1 1 6
Mysore (10s.)	13 0	13 9
Nundydroog (10s.)	1 17 0	2 1 6
Ooregum (10s.)	5 6	7 6
AMERICA:		
Camp Bird (2s.), Colorado	4	6
Exploration (10s.)	3 0	3 0
Frontino and Bolivia, Colombia	1 0 0	1 2 0
Mexican Corporation (10s.), Mexico	4 9	4 6
New Goldfields of Venezuela (5s.)	4 0	5 9
St. John del Rey, Brazil	1 7 6	1 5 6
Santa Gertrudis, Mexico	6 6	6 3
Viborita (5s.), Colombia	—	4 3
MISCELLANEOUS:		
Chosen, Korea	6 9	7 3
New Guinea	6 3	5 0

COPPER:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
Bwana M'Kubwa (5s.), Rhodesia	3 9	4 0
Esperanza Copper, Spain	7 3	6 3
Indian (2s.)	1 3	1 9
Loangwa (5s.), Rhodesia	1 6	1 6
Messina (5s.), Transvaal	5 6	5 6
Mount Lyell, Tasmania	19 0	18 0
Namaqua (£2), Cape Province	2 6	—
Rhodesia-Katanga	11 3	10 0
Rio Tinto (£5), Spain	16 5 0	14 10 0
Roan Antelope (5s.), Rhodesia	9 9	11 0
Tanganyika Concessions	17 0	18 0
Tharsis (£2), Spain	2 16 3	2 17 6

LEAD-ZINC:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	18 6	1 1 0
Broken Hill, North, N.S.W.	2 18 9	2 18 9
Broken Hill, South, N.S.W.	2 0 0	1 18 9
Burma Corporation (10 rupees)	10 3	10 6
Electrolytic Zinc Pref., Tasmania	1 3 9	—
Mount Isa, Queensland	12 0	10 6
Rhodesia Broken Hill (5s.)	1 6	1 9
San Francisco (10s.), Mexico	9 0	8 6
Sulphide Corporation (15s.), N.S.W.	8 0	7 0
ditto, Pref.	11 0	10 6
Trepca (5s.), Yugoslavia	8 6	9 0
Zinc Corporation (10s.), N.S.W.	1 3 9	1 3 9
ditto, Pref.	3 5 0	3 5 0

TIN:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
Aramayo Mines (25 fr.), Bolivia	15 0	13 9
Associated Tin (5s.), Nigeria	5 0	4 6
Ayer Hitam (5s.), Malay	11 9	11 3
Bangrin, Siam	13 6	13 0
Bisichi (10s.), Nigeria	6 3	5 9
Consolidated Tin Mines of Burma	4 0	2 6
East Pool (5s.), Cornwall	9	9
Ex-Lands Nigeria (2s.)	1 3	1 3
Geevor (10s.), Cornwall	3 6	2 6
Gopeng, Malay	1 10 0	1 7 6
Hongkong (5s.), Malay	13 6	13 6
Idris (5s.), Malay	7 0	6 3
Ipoh Dredging (16s.), Malay	15 6	14 6
Kaduna Prospectors (5s.), Nigeria	3 6	5 0
Kaduna Syndicate (5s.), Nigeria	12 0	12 6
Kamunting (5s.), Malay	5 4	5 3
Kepong, Malay	7 6	7 6
Kinta (5s.), Malay	5 6	5 0
Kinta Kellas (5s.), Malay	5 0	4 6
Kramat Pulai, Malay	17 6	15 0
Kramat Tin, Malay	1 10 0	1 6 0
Lahat, Malay	5 0	—
Malayan Tin Dredging (5s.)	17 9	16 6
Naraguta, Nigeria	8 9	8 9
Pahang Consolidated (5s.), Malay	5 6	5 0
Penawat ($1), Malay	1 3	—
Pengkalen (5s.), Malay	8 9	8 3
Petaling (2s. 4d.), Malay	9 9	10 0
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	16 3	16 3
Siamese Tin (5s.), Siam	7 6	7 6
South Crofty (5s.), Cornwall	2 9	2 3
Southern Malayan (5s.)	9 3	9 3
Southern Perak, Malay	1 5 0	1 5 0
Southern Tronoh (5s.), Malay	5 6	5 6
Sungei Besi (5s.), Malay	7 6	7 0
Sungei Kinta, Malay	11 6	10 0
Tanjong (5s.), Malay	7 0	7 0
Tavoy (4s.), Burma	4 0	4 6
Tekka, Malay	12 0	10 0
Tekka Taiping, Malay	12 0	10 0
Temoh, Malay	—	10 0
Toyo (2s. 6d.), Japan	2 6	2 6
Tronoh (5s.), Malay	15 0	13 9

DIAMONDS:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
Consol. African Selection Trust (5s.)	15 0	16 9
Consolidated of S.W.A. (10s.)	4 3	4 9
De Beers Deferred (£2 10s.)	4 0 0	4 10 0
Jagersfontein	1 1 3	1 3 9
Premier Preferred (5s.)	1 5 0	1 10 0

FINANCE, Etc.:

	Oct. 10, 1932 £ s. d.	Nov. 10, 1932 £ s. d.
Anglo American Corporation (10s.)	11 6	12 9
Anglo-Continental (10s.)	4 0	3 9
Anglo-French Exploration	15 0	15 0
Anglo-Oriental (5s.)	6 6	6 0
ditto, Pref.	11 3	11 0
British South Africa (15s.)	18 6	16 6
Central Mining (£8)	11 7 6	12 7 6
Consolidated Gold Fields	1 16 3	1 18 9
Consolidated Mines Selection (10s.)	9 6	9 9
Fanti Consols (8s.)	8 0	8 3
General Mining and Finance	1 6 9	1 7 0
Gold Fields Rhodesian (10s.)	4 3	4 0
Johannesburg Consolidated	1 11 6	1 15 3
London Tin Corporation (10s.)	9 6	9 3
Minerals Separation	3 5 0	3 5 0
Mining Trust	—	4 3
National Mining (8s.)	6	10
Rand Mines (5s.)	3 18 9	4 5 6
Rand Selection (5s.)	11 6	13 9
Rhodesian Anglo American (10s.)	11 0	10 0
Rhodesian Selection Trust (5s.)	5 3	5 3
Rhokana Corp.	4 12 6	4 12 6
Tigon (5s.)	3 0	2 9
Union Corporation (12s. 6d.)	2 19 0	3 8 9
Venture Trust (6s. 8d.)	5 3	6 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, 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.

THE WILLOW CREEK DISTRICT, ALASKA

An account of the gold lodes of the Willow Creek district of Alaska by J. C. Ray appears in *Mining and Metallurgy* for September. The author states that the Willow Creek district, as now limited by prospecting and mine development, comprises an area of approximately 112 sq. miles. The district is situated in the south-western portion of the Talkeetna Mountains, a few miles north of the head of Cook Inlet. The mine camps are easily accessible by good motor roads from Wasilla, a small town on the Alaska railway, 45 miles north of Anchorage. From Wasilla a road enters the Talkeetna Mountains through the picturesque gorge of the Little Susitna River. Fishhook Inn, 16 miles from Wasilla, is the only public roadhouse in the district. From it all properties may be quickly reached by car. During the summer of 1931 a road was being completed to the western portion of the district from Willow, a station about 75 miles from Anchorage and 30 miles beyond Wasilla. Although the rail haul from the coast is greater, this road has the advantage of all-year hauling and eliminates heavy grades to the camps on Craigie Creek. The open season is about four months, from the middle of June to the middle of October. All-year mining operations are quite practical if adequate camp buildings are constructed. At present the Lucky Shot mine is the only property equipped with a winter camp. This company also operates its caterpillar tractors throughout the year on the Willow Creek road. Much snow remains in the hanging valleys and glacial cirques up to the middle of June and snowslides often make the roads through passes and narrow valleys impassable until early July.

The first gold produced from the Willow Creek district was from placers on Willow Creek and Grubstake Gulch. Between 1897 and 1905 about $25,000 is reported to have been recovered. Since 1905 there has been no appreciable production of placer gold. Placer gold is known to occur on Fishhook Creek, but the presence of innumerable large boulders makes operations unprofitable. Lode gold was first produced in the district in 1909, when the Gold Bullion mine began treating its ore in a small three-stamp mill. Since 1909 approximately $5,500,000 in gold has been produced, largely from nine mines. These mines may be grouped as follows: On Craigie Creek, the Gold Bullion, War Baby, and Lucky Shot; on Fishhook Creek, the Martin, Independence, and Gold Cord; on Archangel Creek, the Talkeetna and Fern mines; and on lower Reed Creek, the Mabel mine. During the 1931 open season the only mines in operation were the Lucky Shot, Gold Cord, Mabel, and Fern. In addition to the above-named properties some work was in progress on several prospects. Approximately 80 men are employed at the Lucky Shot mine throughout the year.

The Talkeetna Mountains occupy a region deeply scarred by glacial erosion. At altitudes above 2,500 ft. the relief assumes proportions of rugged grandeur. Typical U-shaped glacial valleys separate the ridges, which in turn are deeply scalloped by closely spaced glacial cirques. Lateral moraines extend far up the valley walls, often forming two or more benches. Post-glacial talus overlaps the upper edges of the glacial fill, thus further obscuring the underlying formations. Within the Willow Creek district proper, elevations vary between 1,500 ft. in the valley of the Little Susitna River and 6,000 ft. on the highest peaks in the north-eastern portion of the district. Farther to the north-east, altitudes of 8,000 ft. are reached where only the highest peaks and ridges project above the perpetual ice of the Talkeetna and Chickaloon glaciers. Above the lateral moraines and talus slopes precipitous cliffs form the walls of narrow, ragged ridges, which frequently exhibit saw-toothed or grotesque silhouettes and craggy pinnacles.

Willow Creek and its tributaries drain the western portion of the district. Willow Creek flows westward from its head waters in the central part of the district and joins the Susitna River some four miles east of Willow Station. Craigie Creek occupies a hanging valley to the north of Willow Creek and flows into the latter from the north-east near the western limit of the district. Little Susitna River drains the eastern border of the district. It flows southward through the Talkeetna Mountains, but turns sharply westward after entering

SKETCH MAP SHOWING WILLOW CREEK DISTRICT.

the swampy floor of the Susitna valley and finally joins the Susitna River near the head of Cook Inlet. Fishhook Creek and Reed Creek with its tributaries Archangel and Fairangel Creeks flow into the Little Susitna from the north, where they form the drainage basin of the east-central portion of the district. Willow Creek and Little Susitna River maintain a flow during the winter, which is reported to be sufficient for the generation of hydro-electric power to supply the needs of the district. During the summer these streams assume torrential proportions.

Geology.—Quartz-diorite is exposed in most of the district and the productive gold-quartz veins occur therein. Along the southern portion of the district southward-dipping Tertiary sediments lie unconformably on the quartz-diorite and form the southern slopes of the Talkeetna Mountains. Bituminous coal in commercial quantities occurs in the Tertiary sediments in the Matanuska valley, a few miles to the south. At present the U.S. Geological Survey is conducting drilling operations to determine the extent and thickness of anthracite coal on Anthracite Ridge, some 30 miles east of the Willow Creek district. The south-eastern portion of the district is occupied by a mass of mica schist, presumably of pre-Cambrian age. Its structural relations to the quartz-diorite are uncertain. It may be a roof pendant, a floated-in block, or a faulted-up portion from the floor of the diorite intrusive.

Quartz-diorite, with monzonitic phases, forms the greater portion of the Talkeetna Mountains. Geologic reconnaissance has determined the areal distribution and established the batholithic character of this intrusive. On the north and east, along the general course of the Talkeetna River, it intrudes early Jurassic greenstones and other metamorphic rocks of early Jurassic age. Late Jurassic sediments contain erosional fragments of a similar quartz-diorite and its differentiation phases. The relation of the intrusive to the middle Jurassic sediments is uncertain. Until recently the age of the Talkeetna batholith was tentatively placed as lower-middle Jurassic. However, intrusives similar in nature to the Talkeetna granitics are now known to intrude early Cretaceous sediments in the Alaska Range to the north. Scattered exposures of similar granites, lying between the two batholithic intrusives, indicate that they may have a common source, thus suggesting that the Talkeetna batholith may have been intruded during the late Cretaceous or early Tertiary. Reconnaissance has shown the Talkeetna massif to be composed predominantly of quartz-diorite, but differentiation phases within the mass vary from diorite to quartz-monzonite and peripheral phases sometimes assume the basic quality of a gabbro. Within the Willow Creek district quartz-diorite predominates. The rock is generally coarsely crystalline and exhibits a speckled black and white pattern except in the vicinity of the gold-quartz veins where the development of chlorite sometimes gives it a distinctly greenish tinge, or metasomatic replacement by ankerite gives it a dull bleached appearance. The quartz-diorite is cut by numerous dykes of dacite, aplite, and pegmatite. Flow structure, schlieren, and swarms of angular fragments of an earlier crust in the diorite suggest that the present erosional surface is not far below the original roof of the intrusive.

Mineralizers were active soon after the intrusion of the quartz-diorite magma. Bornite is occasionally found in minute particles in the unaltered quartz-diorite. It also occurs in a later phase associated with chalcopyrite as a replacement of pegmatite dykes. Fairly high-temperature chalcopyrite-molybdenite-quartz veins occur at numerous places in the district ; also an early type of chalcopyrite-galena-gold-quartz mineralization in slightly opened joint planes. These latter the author considers to belong to a peripheral phase of early mineralization and are not directly connected with the commercially important gold-quartz veins.

The intrusion of the dyke rocks and the metallic mineralization outlined above were all earlier than the formation of the gold-quartz veins of proved commercial value. The commercial veins are of the intermediate temperature or mesothermal type. Structurally they occur as a combination of composite veins or lodes, fissure fillings modified by wall-rock replacement, and quartz lenses which in places reach a thickness of 14 ft. The vein filling is predominantly massive quartz, which exhibits coarsely crystalline hypidiomorphic and comb textures. Banding is developed in much of the quartz and is due partly to the later reopening of the veins and partly to the distribution of impurities. No crustified included wall-rock fragments are present. Cavities and drusy deposits are markedly absent. Quartz of three periods has been recognized. An earlier massive quartz has been brecciated and cemented by a later massive quartz. Pyrite and arsenopyrite, with minor amounts of chalcopyrite and sphalerite, were deposited with these two generations of quartz, but no appreciable amounts of gold. A third generation of quartz was introduced after further shattering of the earlier quartz. With this third generation were introduced tetrahedrite, galena, native gold, and possibly a small amount of gold telluride. The late quartz has a prevailingly microcrystalline texture and develops ribbon structure in the earlier vein filling. The gold occurs as isolated interstitial fillings in and near the late quartz and as a replacement of all the earlier sulphides. It was the last metallic mineral to be deposited by the mesothermal solutions.

Alteration of the country rock is intense in the zones of the composite veins and in most of the rock enclosed between the main walls of the fracture zones. The rock alteration is due to heated solutions which have developed chlorite, pyrite, sericite, secondary microcrystalline quartz, and large amounts of ankerite. Ankerite, an iron-bearing dolomite, occurs as a metasomatic replacement of the earlier alteration minerals (excepting pyrite) and as a replacement of the primary minerals in veinlets traversing the wall rocks. It is generally accompanied by the deposition of secondary microcrystalline quartz.

With one exception the productive mines have been developed along a zone of mineralization some eight miles long and extending in a north-easterly direction across the district. The veins themselves have a general north-easterly strike and appear to be arranged en echelon along the general zone of fracturing. The dips are prevailingly northward and vary in the several veins from 20° to 47°.

The Mabel mine lies some two miles to the east of the above-described zone. Its strike is approximately east–west with a dip to the north. About three miles farther to the east is the Gold Mint prospect which has exposed a small faulted segment of a mesothermal vein. This property is high on the eastern valley wall of the Little Susitna River, near the contact of the Tertiary sediments with the quartz-diorite.

The maximum length of the veins is unknown. Transverse faulting has cut the veins into segments, which vary in length up to 1,200 ft. The Lucky Shot has developed such a 1,200-ft. segment between two transverse faults. A faulted segment of the same vein has been developed in the War Baby mine to the north-east and surface work has proved its continuation for something over 1,500 ft. to the south-west, a total of 3,300 ft. In general, mine development has failed to discover vein extensions beyond important transverse faults.

In the south-western portion of the district the average assay value of the ore mined is somewhat over $50 a ton in gold, but gradually decreases to $25 a ton in the north-eastern portion. In the south-western portion of the district a single shoot produced over $600,000 and the average thickness of the ore was 6 ft. The ores are surprisingly low in silver content.

Since the formation of the veins intensive faulting has cut both the quartz-diorite and the Tertiary sediments into numerous blocks. That these faults are comparatively young may be inferred from their influence on the present-day topography. A graben is exposed in the ridge on the west of upper Craigie Creek and the recent glacial ice has failed to erase the sharpness of the fault scarps. These particular faults continue across Craigie Creek valley to the eastward, where they have played a fatal rôle in isolating extensions in strike and dip of the Gold Bullion vein, which was a segment left high on the ridge between Craigie Creek and upper Willow Creek valley. All the productive properties of the district have struck transverse faults. They intersect the veins at varying angles and the vein has been discovered beyond such a fault only at the War Baby and Lucky Shot mines. No doubt careful surface work and mapping of these faults would often be rewarded by discovery of the faulted segments of profitable veins. In the Lucky-Shot-War-Baby fault the horizontal displacement is approximately 800 ft. and the fault movement appears to be normal.

Post-mineral movements in the plane of the veins have formed slickensided walls, which cause pinches and swells in the veins that cannot always be attributed to the original distribution of the vein filling; segments of the veins are known to lie outside of these slickensided walls. Exploration has generally been confined between these post-mineral slickensided walls, and the actual limits of mineralization are now known. It is certain that in many places valuable ore has been passed by, owing to lack of cross-cutting. Judicious cross-cutting on present mine levels might lead to the discovery of valuable bodies of ore thus far unsuspected.

Economics.—*Open Season.*—Although the open season is only about four months, mining operations may be carried on during the entire year if adequate camp facilities are provided. The winter's supplies must be taken in during the summer except for properties on Craigie Creek where the Willow Creek road renders all-year hauling possible.

Transport.—Transport of heavy supplies is accomplished by caterpillar tractor. Lighter haulage is by truck. The Willow Creek Mines, Inc., operating the Lucky Shot and War Baby mines have their own haulage equipment. The smaller properties contract haulage. Automobile transportation is available into the district from Wasilla at all times during the open season.

Labour and Wages.—An adequate supply of skilled labour for mining operations is available at Anchorage. Wages are about the same as in the camps of the western United States plus board and room.

Timber.—Mining timber can be secured by contract from the lower courses of the Little Susitna River and Willow Creek. The available supply consists of spruce poles which are rarely more than 12 in. at the butt end. The supply is adequate for the needs of the district, as the ground stands well and not much timber is required. Building lumber is best secured from Seattle in car-load lots, as locally produced dimension lumber is of poor quality.

Housing and Building Construction.—The vigorous and long winters have an important influence on mining operations in the Willow Creek district. Only one company in the district has constructed a camp which combines resistance to the prevailingly low winter temperature, economy in heating, and a maximum of living convenience such as showers, laundry and toilet facilities. The general layout is the result of experience and may be of interest to anyone operating in a cold climate. The Willow Creek Mines, Inc. has built such a camp at its Lucky Shot mine on Craigie Creek. It houses 100 men in three buildings; two dormitories which accommodate 40 men each; and one combination cook-house and dining room, the second story of which accommodates the mine and mill staff.

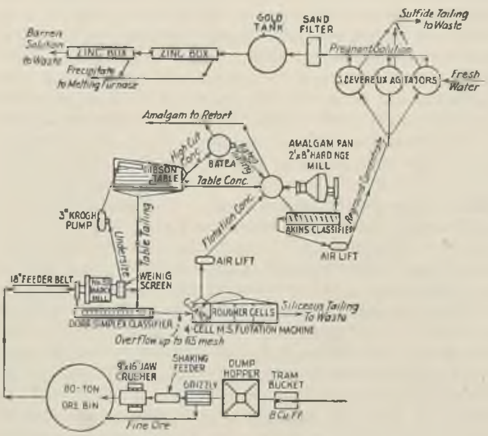
The combination mill building and power-plant housing is of timbered construction. The assay office and living quarters are of frame construction. All buildings are covered with double sheathing laid diagonally in opposite directions. Tarred building paper is laid on horizontally between the double sheathing. The outside of all buildings is covered with a light ply composition roofing paper. The inside walls and ceilings of the assay office and living quarters are panelled with insulating board. All buildings are double-windowed and the main entrances are vestibuled. Floors are double, with building paper between. Finished floors are laid with 1 by 4-in. tongued and grooved, vertical-grained pine. Heating in all buildings is by hot water, piped from the cooling systems of the diesel engines in the power plant. This water is superheated in a boiler using the exhaust from the same engines.

The first floor of each dormitory is divided into club room, locker room, and sanitary equipment consisting of wash room, showers, laundry tubs, and toilets. The two upper stories are reached by housed-in outside stairs. Sleeping cubicles are partitioned from floor to ceiling, without doors, thus insuring the circulation of fresh air which is provided by ventilators. Single-deck iron bunks are provided; two to a room.

All buildings are constructed on piles which are sunk through moss and loose muck to a solid footing on boulders or gravel. Fire protection consists of numerous fire extinguishers and a housed-in water tank erected on the slope above the camp. All piping and sewers are carefully boxed in sawdust. Sewage discharges into the creek below camp. Auxiliary heating is supplied by stoves and concrete brick chimneys.

Power. — A small amount of water power is generated at the operating properties to augment that furnished by internal-combustion engines. This local power is available only during the open season as the streams are frozen and seepage ceases when freezing sets in, generally by the latter part of October. All-year hydro-electric power can be produced on the lower courses of Willow Creek and the Little Susitna River. Coal is readily available in the Matanuska Valley for the production of electric power. Power might also be obtained from the hydro-electric plant at Eklutna, about midway between Anchorage and the Willow Creek district, which furnishes power and light to Anchorage.

Milling Practice.—Until installation of the new mill at the Lucky Shot mine, milling practice consisted of grinding, crushing, amalgamation, concentration, and cyanidation of the tailing. The old mill of the Lucky Shot mine used stamps for crushing. Other properties of the district are still using Denver mills of 5 to 20 tons' capacity. As a large percentage of the gold occurs in tiny particles, fine-grinding in closed circuit is an obvious necessity.



FLOW-SHEET OF THE LUCKY SHOT MILL.

The new mill at the Lucky Shot mine, put into operation early in 1931, embodies recent practice. The salient features of the ore treatment are concentration of the sulphides and their amalgamation and cyanidation for recovery of the gold. Concentration is accomplished on a Gibson table and a four-cell M. S. flotation machine. Siliceous tailing from the flotation machine is discarded without further treatment. About 85% of the gold is obtained in the top cut on the Gibson table. The top-cut concentrate is collected in buckets and the gold amalgamated once a day in a batea. The second cut from the table goes to an amalgamating pan which is in closed circuit with a small Hardinge mill and Akins classifier. The sulphide tailing from the batea is added to this closed circuit. Siliceous material or tailing from the Gibson table is returned to a Dorr classifier and again goes through the ball-mill circuit. Overflow from the classifier passes to the flotation machine. The flotation sulphide is added to the table concentrate in the pan-amalgamation circuit. Siliceous tailing from flotation is discarded. All tailing from pan amalgamation is cyanided in Devereux agitators. The sulphide, after cyanidation, runs about $40 in gold and is stored for shipment. The flotation tailing runs from 90c. to $2 per ton. The ratio of concentration is about 68 to 1.

Ore Haulage.—With the exception of the Gold Cord, where the adit is only 75 ft. above the valley floor, all of the productive properties have been developed through adits located high on the valley wall at elevations of 400 to 1,400 ft. above the mills. Ore is delivered to the mills by aerial tramways. These tramways are of the double reversible type, generally with a single span between the mine and mill. At the Lucky Shot mine two such tramways are in operation. The one from the lower adit is a single span 1,950 ft. long; the upper terminal being some 530 ft. above the dumping floor of the mill. The tramway to the upper adit is 2,250 ft. long, is constructed with a single span, and attains an altitude of 825 ft. above the mill. The buckets have a capacity of about 800 lb.

Mine Water.—The problem of handling mine water has presented no difficulties as the properties are operated through adits high on the valley walls. In such winzes as have been sunk the seepage could be handled by bailing methods.

CONCLUSIONS.—The gold-quartz veins of the Willow Creek district belong to the mesothermal type and may be expected to continue downward for several thousands of feet. The veins occur in an essentially homogeneous quartz-diorite of batholithic form; wall-rock differences will therefore have no influence on the distribution of gold within the veins. The deposits are of the composite-vein type although quartz lenses have also been formed, up to 14 ft. thick. One such lens has produced over $600,000 in gold.

The ore minerals, the character of wall-rock alteration, and the structure of the veins are strikingly similar to those of the Grass Valley and Nevada City districts, California.

Only two of the nine productive mines of the district have reached a depth of 500 ft. below their vein outcrops and the lowest workings of all properties except the Gold Cord are several hundreds of feet above the valley floors.

The actual widths of the veins or mineralized lodes are not known. Judicious cross-cutting from the present workings might lead to the discovery of valuable bodies of ore which lie outside of post-mineral slickensided walls.

Further exploration of the productive properties at their present depth of workings, together with the development of new properties, should increase materially the present output. From the type of the veins it may be assumed that the general character of their mineralization and structure will not change materially in 3,000-ft. depth and that ore-shoots may be expected to at least that depth and with the same frequency as found at the depths already attained in the mines. Without adequate development an estimate of future production is hazardous, but the well defined character of the veins, coupled with the fact of a past production in excess of $5,000,000, would seem to justify the belief that large reserves of ore exist for future production, down to a depth of 3,000 ft. The author points out, however, that, in large part, the easily accessible ore-shoots have been exploited and that future exploration will require the careful expenditure of large sums of capital by experienced mine operators.

AGITATION

In *Industrial and Engineering Chemistry* for October A. McL. White, S. D. Sumerford, E. O. Bryant, and B. E. Lukens give the results of a study of the suspension of sand in water. They conclude that, in the case of an insoluble solid in a liquid, maximum suspension of the solid is attained after a very short period of agitation. Uniformity of concentration of the suspended solid is never obtained, but is approached more closely when the paddle is near the surface of the liquid than when it is close to the bottom of the tank. Maximum suspension of the solid is obtained when the paddle is near the bottom of the tank, although the liquid above the stirrer is low in suspended matter. There is a hydraulic sizing of particles in the tank. The large particles remain on the bottom near the centre of the tank, whereas the small ones are carried into suspension by the flow of the liquid. Sand concentration does not indicate the stream flow of the liquid, although it is probably a practical measure of its velocity.

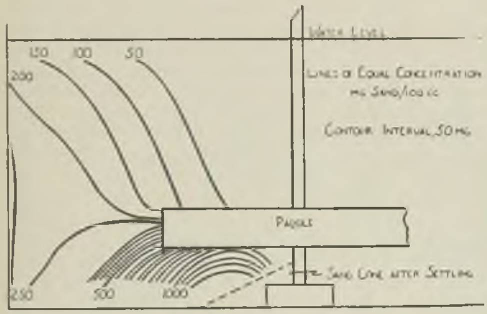


Fig. 1.

The authors say that it has been shown that the common paddle agitator is an efficient stirring device when used to mix a solution of an electrolyte with water, or for dissolving a soluble material in a solvent. However, there seem to be no data on the mixing or suspending of an insoluble solid in a liquid by means of a paddle agitator. It is the purpose of their paper to present evidence on such a case.

Since mixing had been found to take place completely within 2 or 3 minutes when used on electrolytes, it was decided that for their experiments screened sand and water would be used. This would eliminate the variable of changing surface area and, it was hoped, would slow down the rate of mixing sufficiently to enable a study of the comparative value of various agitators to be made. However, as will be shown, mixing was very rapid, but uniformity of sand distribution was never realized. For this reason, the emphasis was laid on the distribution of the suspended solid throughout the liquid rather than on the rate of mixing.

The equipment used in the tests consisted of a 500-gallon cylindrical steel tank 4 ft. 4 in. (132 cm.) in diameter. This was equipped with a paddle agitator with a blade 2 ft. 1 in. (63·5 cm.) in length, 3·5 in. (8·89 cm.) wide, and 2 in. (5·08 cm.) thick, mounted on a steel shaft running vertically through the centre of the tank and terminating in a step bearing at the bottom. The agitator was driven by a ring gear and pinion through a jack-shaft. The paddle, whose ends had been bevelled off at an angle of 45° away from the direction of rotation, was moveable vertically so that it could be fixed at any desired height above the bottom of the tank. A constant agitator speed of 37 r.p.m. was adopted for these experiments. The sand was screened to give a product of approximately 65 mesh.

Samples were obtained by means of glass tubes, 5 mm. in diameter, inserted into the tank through holes in the wall. These holes were spaced vertically 4 in. (10·16 cm.) apart, the lowest 2 in. (5·08 cm.) from the bottom of the tank, and the highest 22 in. (55·88 cm.). The tubes were 26 in. (66·04 cm.) long, and were so fitted that they could be inserted into the tank to any desired distance up to this limit. At their outer end, closure was effected by means of rubber tubing and a pinchclamp. For these tests, it was decided arbitrarily to keep the water level 2 ft. (60·96 cm.) above the bottom of the tank. This corresponds to 220·5 gallons of water.

During a run, samples of the sand-water mixture were withdrawn periodically for analysis. To

Sample of Experimental Data

(Sand, 20 lb.; paddle, 17·25 in. from bottom; samples, 0·5 in. from wall of tank)

Distance from Bottom Inches	*Time* Minutes	*Amount Sand in Water* *Run* 63 Gram/100 cc.	*Run* 64 Gram/100 cc
22	1		0·087
	6	0·126	
	7		0·114
	12	0·121	
	13		0·115
	18	0·118	
	19		0·119
	24	0·119	
18	2		0·128
	5	0·145	
	8		0·130
	11	0·130	
	14		0·129
	17	0·135	
	20		0·127
	23	0·128	
14	3		0·137
	4	0·148	
	9		0·131
	10	0·131	
	15		0·133
	16	0·135	
	21		0·131
	22	0·137	
10	3	0·162	
	4		0·144
	9	0·143	
	10		0·139
	15	0·142	
	16		0·131
	21	0·135	
	22		0·135

eliminate the effect of the sand which settled out in the sampling tubes, the tubes were allowed to drain for 15 seconds before collecting the samples. This period was found sufficient to flush out all material trapped from the previous test. The samples thus collected were filtered through weighed Gooch crucibles, the volume of water measured, and the results calculated as milligrams of sand per 100 cc. of water. Two series of runs were made, one using 67 lb. of sand, the other using 20 lb. of sand.

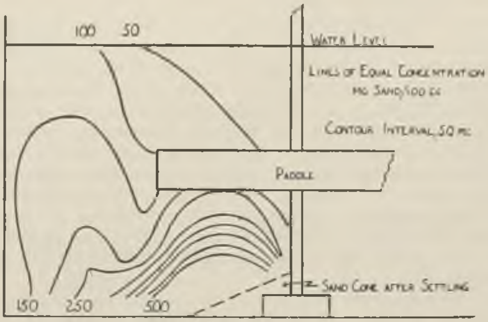


Fig. 2.

For each of the two amounts of sand in the tank, experiments were conducted with the sampling tubes inserted so as to withdraw samples successively at 0·5, 2·0, 6·0, 10·0, 12·0, 14·0, 14·0, 18·0, and 22·0 in. (1·27, 5·08, 15·24, 25·40, 30·48, 35·56, 45·72, and 55·88 cm.) from the wall of the tank. For each tube, a sample was withdrawn every 5 minutes until five samples were secured ; on repeating the run, the times of withdrawal were staggered so as to fill the intermediate times.

The results of all the runs are summarized in Figures 1, 2, and 3, in which lines of constant sand concentration, expressed in milligrams of sand per 100 cc. of water, are drawn for the tests using 20·0 lb. of sand. In Figure 1, the lower edge of the paddle was 5·25 in. (13·33 cm.) from the bottom of the tank ; in Figure 2, 11·25 in. (28·56 cm.) ; and in Figure 3, 17·25 in. (43·81 cm.). The shape of the curves was the same for 67 lb. of sand, but the sand concentrations were much higher. In each case, maximum concentration of suspended sand was reached within 2 min.

It will be noted that the sand concentration varies widely from point to point throughout the tank, and that there is a marked difference in the action of the paddle for different paddle positions. The lowest concentrations are found above the paddle, with the highest beneath it near the bottom of the tank. This is further verified by the distribution of the sand after settling. There is in all cases a cone of sand enclosing the step bearing of the agitator shaft ; for 67 lb. of sand, there is, in addition, an irregular layer of sand across the bottom of the tank. In the case of 20 lb. of sand, there is a layer of sand around the wall of the tank, with a clear space between this ring and the central cone. There is a marked eddy at the end of the paddle, which seems to account for the little sand on the bottom beyond the end of the paddle.

It seems, from Figures 1, 2, and 3, that the upper paddle position results in the most uniform distribution of material. The liquid above the paddle is in all cases low in sand, and this space seems to be largely ineffective. In the low paddle position, there is a large amount of suspended solid below the paddle, but this zone does not seem to extend much beyond the agitator. These results are most readily interpreted on the basis of a hydraulic classification of the sand into various size fractions.

In order to confirm the theory that selective separation of sand particles was taking place because of different velocity areas in the tank, the mixture was thoroughly agitated and, while the paddle was kept turning, large samples were run from different portions of the tank. A standard screen analysis on the sand obtained in this manner showed that 50% of the sand was finer than 150 mesh. As only 10% of the sand placed in the tank was finer than 150 mesh, this shows that the velocity of the agitator was such as to place in suspension only the smaller particles, whereas the heavier particles of sand remained on or near the bottom. This accounts for the cone of sand beneath the paddle. The cone is evidently composed of the large sand particles which are never placed in suspension, but are merely moved around a small circle on the bottom.

To obtain further evidence on the motion of particles under the influence of the agitator, small glass vials were filled with water until their apparent specific gravity was slightly greater than unity. These were placed in the tank and their motion observed while the agitator was turning. There was found to be little tendency for the vials to rise above the paddle, the motion being outward from the end of the stirrer. This was followed by a downward motion near the wall of the tank, and then an irregular motion as the bottles returned beneath the paddle. Heavier objects, such as fully-filled vials, simply rolled around the bottom of the tank at a distance from the shaft of about half the length of the paddle. Since these experiments show that there is a particle sizing effect due to different velocities in the tank, an ordinary cylindrical tank equipped with a paddle agitator might be used effectively for hydraulic separations.

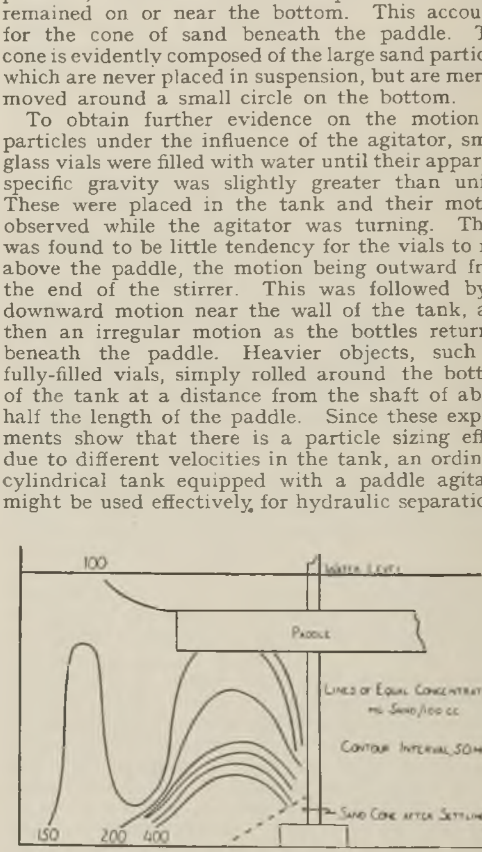


Fig. 3.

Although sand concentration seems to be a measure of the degree of mixing, it probably does not accurately picture the stream lines of the liquid. A given particle of sand is not intimately bound up with a given filament of water. The sand may drop from one stream line to another, depending on the relative velocities of the two filaments. However, for practical purposes, the lines of sand concentration seem to represent qualitatively the liquid velocities at various points.

QUE QUE, SOUTHERN RHODESIA

The Geological Survey of Southern Rhodesia has now issued Bulletin No. 20, in which A. M. Macgregor deals with the geology of the country around Que Que, in the Gwelo district. The district is described as a rectangular tract of country surrounding Que Que, bounded arbitrarily on the north and south by the 18° 40′ and 19° 0′ south parallels of latitude and on the west and east sides by the 19° 0′ and 19° 30′ east meridians respectively. The tract has an area of 750·6 square miles. The railway from Bulawayo to Salisbury passes through the area from south to north. Que Que station is about 5 miles from the southern margin, and the sidings of Gado, Samwari, and Sherwood are also within the area. Que Que is situated approximately at the geographical centre of Southern Rhodesia, and is the seat of a thriving gold-mining industry. The town has grown up around the Globe, Phœnix, and Gaika mines. The Phœnix mine has produced nearly £9,000,000 worth of gold at standard value and is Rhodesia's largest producer. The Gaika mine is situated 2 miles to the south, the Sherwood Starr mine 8 miles to the north, and the old Bell mine about 6 miles to the west of the town. The total output from the area up to the end of 1931 is 3,250,531 oz. of gold, worth £13,652,230 at standard value, from 4,819,774 tons of ore treated. The country south of the Umniati River, which crosses the north-eastern corner of the area, forms part of the Gwelo administrative and mining districts. The country north of the river is part of the Hartley district.

With the exception of the neighbourhood west of Que Que, where a cluster of hills diversify the landscape, the area described is one of rather monotonous flatness. The plateau has a mean altitude of about 4,000 ft. along the southern margin of the map and drops gently to about 3,650 ft. in the north. The few hills, most of which have the form of steep-sided ridges with narrow level tops, rise to a maximum height of about 300 ft. above the general level of the country. The hills are mainly composed of jaspilite or other hard and resistant rock. The region was formerly covered with trees averaging between 15 and 30 ft. in height, but the extensive and repeated cutting of timber and the subsequent second and third growths from the old stumps, has reduced the greater part of the forest to a tangle of rather dense bush.

The valleys are wide and shallow except where a river cuts through a range of hills, where the banks may be steep and precipitous. In the eastern part of the area the principal rivers, the Umniati and the Sebakwe, flow towards the west-north-west with approximately parallel courses. This direction is obliquely across the northerly slope of the plateau and, as a consequence, the larger tributaries to each river join the left bank and the country between the rivers drains mainly to the north. Without altering its general course the Sebakwe River cuts its way in turn through three ranges of hills, giving rise to some beautiful country culminating in the spectacular Sebakwe Poort. There the river flows through a gorge cut in a range of nearly vertical conglomerates between cliffs which rise sheer out of the water to a height of almost 400 ft. The range extends only a mile to the north and but little more towards the south. A relatively small deviation of the course, therefore, would enable the river to flow round the end of the hill. This presents one of several interesting problems in the local topography.

The only undisputed natural method by which a nearly flat land surface, composed of solid rock, can be formed is the usual process of denudation by rain and rivers, controlled by the approach to sea level, below which this denudation obviously cannot proceed. Some authorities, however, maintain that very prolonged wind erosion in desert regions, the hollows of which become protected by a cloak of sand, must in time produce a nearly flat land surface, which is unrelated to sea level. Probably both of these processes have played a part in the formation of the plateau, the history of which is certainly not simple.

Mr. F. P. Mennell explained the structure of the Sebakwe Poort satisfactorily in 1911. He recognized that many of the ridge-like hills on the highlands of Matabeleland, notably in the lower Gwelo valley, project through a cover of Forest Sandstone of Karroo age and therefore that the hills were in existence before late Karroo times. He writes: "In many places on the plateau there are great ranges of banded ironstone and sometimes other rocks running straight across the main streams, which have to pass through them in narrow and sometimes precipitous gorges. This puzzled me for a long time, and it only became clear on realizing that the streams must have originated prior to the denudation of the sandstones, which once filled all the lower ground even when they formed only a thin capping on the ridges. Their courses were determined by the general slope before this covering was removed; hence their general discordance with what now seems a much more natural direction to have taken." Among other examples he mentions the "poorts" on the Sebakwe and Kwekwe Rivers.

In Mr. Mennell's view, apparently, the relatively smooth surface of the plateau with the rudiments of the present hills upon it corresponds approximately with the floor upon which the Karroo rocks were deposited or, more strictly perhaps, with the zone of weathered rock which underlay the Karroo strata. The present writer is in complete agreement with this view, which is confirmed by the fact that the nearly flat country extends north-westwards to the foot of the Mafungabusi escarpment, where some 900 ft. of Karroo sandstones with overlying basalt rise steeply about it. That rivers which have incised their beds so little in the plateau surface have been able to remove the overlying sandstones so completely may perhaps be explained by the action of a small but torrential rainfall upon rocks contrasting strongly in hardness, whereby the rivers were loaded with sand to the limit of their transporting capacity and erosion of the river beds was impeded.

River System. — The west-north-westerly direction of flow of the Umniati and Sebakwe is shared by many other rivers in Southern Rhodesia, including the majority of those whose valleys are cut in the Kalahari beds. This formation was deposited upon the Karroo and older rocks after a certain period of erosion had taken place. It now occupies a relatively depressed basin in the interior of southern Africa, surrounded by a rim of higher ground bordering the coasts of the sub-continent, The basin is drained by inward-flowing rivers which either dry up in the interior or reach the ocean by way of either the Orange or the Zambezi, the two rivers which have broken their way through the rim of the basin. The west-north-westerly direction of flow in Southern Rhodesia is approximately at right angles to the general direction of the coastline of south-east Africa. It is reasonable to conclude that these rivers were all developed at about the same time upon a surface of Kalahari deposits, following a relative uplift of the continental border, and that for some time after their birth the Umniati and Sebakwe Rivers maintained their west-north-westerly courses towards the centre of the interior depression. In the Que Que neighbourhood this course led across a wedge of Kalahari and Karroo strata, which rested upon the inclined plateau of older rocks and thickened north-westward. The initial grade of the rivers was probably very low and their erosive power consequently was very small. The peaks of the hills which had been buried beneath the Karroo strata were in time exposed to the atmosphere and were gradually worn down nearly level with the surrounding sandy plain, developing the smoothed outlines which the hills display when viewed from a distance.

The later history must have been somewhat as follows : The deepening valley of the Zambezi led in turn to deepening by the Umfuli-Sanyati River. In its upper part this river flows towards the west-north-west, but in its lower course it swings round towards the north-west. The more rapid erosion due to its increased gradient caused its tributaries to cut back southwards through the soft Karroo strata and to capture first the Umsweswe and later the Umniati River. A tributary of this in turn captured the Sebakwe at a point near the present confluence of the Kwekwe. This, however, is not the whole story. There are other features which are not easily explained. In the western part of the area the upper course of the Maliami, part of the Singwangombe, and the lower part of the Sesombi Rivers form a nearly straight south to north line, which if continued northward nearly coincides with the course of the Umniati from the confluence of the Sesombi to that of the Umsweswe. This remarkable course suggests a line of faulting, but no evidence of faulting along this line has been observed. Alternatively, since the three valleys in the Que Que area are all wide and shallow, these rivers perhaps mark the course of a sub-Karroo valley.

The course of the Kwekwe River, which is continued by the lower part of the Sebakwe, presents a rather similar problem, to which a similar explanation seems the most probable solution. Southwards of Que Que this river is flanked by terrace gravels in which the Karroo fossil wood Rhexoxylon is rather abundant—a feature which does not appear to be shared by the valleys of the other rivers. A similar gravel, however, is exposed in a small pit beside the road about a mile west of the Bell Mine. A few crude stone implements were found in this pit, though not definitely in place in the gravel. This suggests that in that neighbourhood even so late as early human times the course of the Kwekwe lay some two miles to the west of its present bed and that the present course has been developed since that time.

The author then describes previous work in the area, going on to give an outline of its geology.

Outline of the Geology.—The neighbourhood of Que Que, like other parts of the Rhodesian goldfield, is formed partly of granite masses of subterranean origin and partly of steeply folded surface-formed rocks, into the marginal portions of which the granites are intrusive. Two granite masses form the eastern and north-western portions of the area respectively. The intervening belt is composed of a variety of rocks which are folded between the granites, the youngest rocks occupying the centre of the belt. The structure of the belt, however, is not that of a simple trough fold but has been produced by movements in different directions at two or more widely separated periods.

With very little doubt the most ancient rocks in the area are the schists occurring near the contact of the eastern granite and forming numerous inclusions in that mass. These schists are composed principally of mixtures, in various proportions, of silicates and carbonates of magnesia, comprising serpentine, talc, and magnesite, with subordinate iron-bearing minerals. Three principal rock types, serpentine, talc-schist, and magnesite-rock, can be recognized according to the predominating minerals. Bands of crystalline micaceous quartzite, of green cherty quartz, or of banded ironstone are associated in places. The origin of these rocks is obscure.

To the west of these rocks, both north and south of Que Que, lies a series of greenstone lavas with interbedded banded ironstones and thin quartzites. The boundary between the two series is marked approximately by a low range of jaspilite hills (jaspery banded ironstone). The actual base of the second series, however, is seen only in the bed of the Sebakwe River, where a thick conglomerate, composed largely of granite pebbles but containing contorted fragments of magnesian schists, close to the contact, is exposed between those rocks and the jaspilite. The form of the pillow lavas west of the jaspilite, moreover, proves that their original lower surfaces are now on the eastern side, which confirms the conclusion that these rocks are younger than the magnesian schists and were deposited upon them. South-westwards of Que Que these pillow lavas with interbedded jaspilites are succeeded by rocks of more siliceous composition, which appear also to be mainly of volcanic origin and comprise felsites, porphyritic rocks and fragmental rocks grading into felspathic grits. These rocks, together with the pillow lavas and jaspilites, are regarded as one formation and are referred to as the "Lower Volcanic Series."

The felsitic rocks just mentioned occupy a roughly triangular area on the map and are overlooked on the western side by the high range of jaspilite hills, among which, a little south of the map margin, the Que Que lime works are situated. These hills trend obliquely across the direction of strike of the felsites and lavas of the Lower Volcanic Series. On the eastern side of the range, conglomerates formed almost entirely of highly carbonated felsitic rocks occur in several places. In general, however, outcrops in this neighbourhood are very scarce and obscure. On the western slope of the range pebbly quartzose grits form crags, and similar rocks are bedded among the pillow lavas farther west. These pillow lavas, like those previously mentioned, have their lower surfaces on the eastern side and therefore appear, at the time they were formed, to have overlain the rocks farther east. The writer considers that these rocks constitute an "Upper Volcanic Series," resting upon the eroded surface of the Lower Volcanic Series.

The volcanic rocks were gently folded on a north-north-west to south-south-east axis and partially eroded before the overlying sediments, which form a wide belt through the centre of the area, were laid down. These sediments are naturally separated into lower and upper divisions, distinguished by the prevalence of fine-grained soft rocks in the former and coarse rocks in the latter. At the margins of the sedimentary belt there is usually either a pale coarse grit or a conglomerate, followed by several thousand feet of mudstones with numerous flakes of mica which glisten on the bedding planes. Natural exposures of these rocks are generally scarce and there can be little doubt that the thickness is exaggerated by repeated folding. With these rocks are generally associated heavy banded ironstones or hæmatite-slates rich in iron and almost devoid of jaspilite.

The upper division of the sediments consists mainly of coarse grits of very dark grey colour and beds of conglomerate. Banded ironstones are absent. At the Sebakwe Poort the conglomerate is exceptional in being composed principally of sub-angular pebbles of pale jasper. The mapping suggests that the deposition of the lower beds was interrupted and that some folding and erosion took place before the upper division was formed. It is therefore proposed to refer to the two divisions as the Lower and Upper Sedimentary Series respectively.

Important earth movements followed the deposition of the sediments, folding them into a deep boat-shaped syncline trending north-east to south-west with steep, or even inverted, dips on the south-eastern side.

The country north-west of the sedimentary belt consists essentially of a monotonous succession of lavas, which are difficult to interpret owing to the comparative rarity of banded ironstone or other bedded formation outcropping sufficiently frequently across the country to be recognized as a marker. Exposures of the greenstones are generally scarce and in many cases the rocks are weathered almost beyond recognition. Unfortunately also this part of the area had been mapped before the succession had been worked out in the east. The little evidence that there is from the posture of the pillow lavas and other observations indicates that the lavas dip south-eastward under the sediments and therefore that they are equivalent to a part or to the whole of the lavas on the eastern side.

The two larger granite masses are both grey biotite-granites relatively rich in soda felspar. While, however, the western granite is a rock of fairly uniform texture, that on the east is a mixed rock, or migmatitic gneiss, containing throughout masses of foreign material in all stages of assimilation. Besides the two larger granites there are several small intrusions of granite which penetrate everything, including the Upper Sedimentary Series.

The epochs of the granitic intrusions are uncertain. Undoubtedly some granite was exposed to erosion before the deposition of the Lower Volcanic Series. Some of the granite boulders in the basal beds of that formation resemble portions of the gneissic granite to the east, but on the other hand they may have been transported from an older granite at a considerable distance.

The principal gold mines are grouped in an area of great geological complexity around but principally northwards of the town of Que Que. The ore-bodies comprise quartz reefs and impregnation deposits containing pyrite and usually a sulphide of antimony or arsenic. The antimonial quartz reefs of the Phœnix mine lie partly in the magnesian schists and partly in the eastern granite. Their development was preceded by the formation of much barren quartz and the intrusion of at least five different series of dykes. The Gaika mine ore-bodies are largely antimonial impregnation deposits in the magnesian schists. The Sherwood Starr mine is an arsenical deposit in brecciated jaspilite of the Lower Volcanic series. The Golden Ridge mine is a pyritic deposit in fractured zones of the banded ironstone of the Lower Sedimentary series, and the old Bell and Riverlea ore-bodies are due to mineralization of the walls of fault fractures in the Upper Sedimentary Series. The Bell ore-body is an antimonial deposit like the mines at Que Que. The gold in the conglomerates in the area is always associated with zones of fracture. In no case is there evidence of an ancient placer. It seems fair to conclude, therefore, that most if not all of the gold deposits are younger than all of the surface-formed rocks which have been described. Some of the gold reefs are cut by dykes of dolerite which, apart from surface alluvial deposits, are the youngest rocks in the area. The remaining geological history is a record of progressive denudation.

HOISTING ROPES

Considering the hoisting rope as a most important link in the chain of operations at a mine, H. M. Hall, in the *Canadian Mining Journal* for October, discusses its efficiency. The author considers it of great importance to have a fair and decisive method for the comparison of the services obtained from different ropes on the same hoist. In many instances, he says, the scale of comparison between two ropes is the number of days or months which elapsed between the installing of the rope and its removal ; in other cases the number of tons, perhaps expressed as foot-tons, lifted by the rope during its lifetime is used as the basis for comparison. But neither of these methods is strictly correct and accurate and they may give very misleading results. It is obvious that elapsed time means nothing when comparing two ropes, one of which has worked continuously, at a high rate, while the other has had considerable periods of idleness or part-time operation. On the other hand, mere tonnage figures may be misleading, as when comparing two similar tonnages, one of which was hoisted in a considerably shorter time than the other. The correct method would therefore seem to be one that combines both concepts of time and tonnage.

The elements, or causes, for wear and ultimate failure of a hoisting rope are composed of two things, load and friction. The load consists of the tensile stresses, due to the dead weights of rope, cage, or skip, and its contents, the bending stresses over sheaves and drums, and the stresses due to acceleration and retardation; while the friction is composed of the internal, between wires and strands, and the external, between the rope surface and the surfaces of sheaves and drums. All of the above elements come into play with each cycle of the hoisting operation, so that in the last analysis, the life of a rope, other things being equal, is a function of the number of trips, and the load in the skip. It is assumed here that, when comparing the service of two ropes, the diameter of drums and sheaves, the fleet angle, and the speed of hoist, the weights of rope and skips, and the height of hoist, are constant, and that the only variables may be the numbers and weights of the skip loads.

C = Installed cost of rope.

W = Total tons hoisted.

T = Number days taken to hoist W tons.

$$Q = \frac{C}{W} \text{ Rope cost per ton (1).}$$

$$S = \frac{C}{T} \text{ Rope cost per day (2).}$$

$$P = \frac{W}{T} \text{ Tons per day (ton-day).}$$

$$K = \frac{C}{P} = \frac{CT}{W} \text{ Rope cost per ton-day (3).}$$

Q, of course, is smaller the greater the value of W, but a large number of tons may be spread over a long period of time, so that actually the wear on the rope is relatively small. Similarly, S is small when T is large, but here again such a small tonnage may be hoisted in a relatively long period of time as to mean but little wear on the rope. On the other hand, K is smallest when T has a low value at the same time that W has a large value, meaning, of course, a high rate of operation for the rope. In other words the most efficient rope is that one which lifts the greatest tonnage in the least time. If for two ropes the T's are the same, the relative costs will vary as the W's, or, if the W's are the same the costs will depend on the T's. All this is as it should be, for a fair comparison, and it will thus be seen that equation (3) gives full consideration to all the variables, while equations (1) and (2) do not. In other words, ropes should be compared on the basis of the rate at which they have worked, i.e. the horse-power they have delivered, rather than merely the tonnage hoisted, or the time operating. Like any other machine, a wire rope is bought for the purpose of performing work, so the service it renders should be measured accordingly.

The following examples, taken from actual figures at well-known Canadian mines, will illustrate the above. At the shaft of one mine one rope raised 590,390 tons in 343 days while on the same hoist another rope lifted 700,350 tons in 468 days. The first rope apparently was the poorer, doing less tonnage in fewer days, yet, when comparing the working rates of the two ropes, and applying equation (3) (assuming that the costs C for the ropes were the same), the rope cost per ton-day for the first is 0·000581 of C and 0·000668 of C for the second.

Again, at another mine one rope hoisted 221,500 tons in 255 days, against 146,300 tons in 150 days by another rope. In spite of the apparent wide difference between these two, the first had a cost per ton-day of ·000115 of C and the second ·000102 of C; not so different after all, and what difference there was is in favour of the second rope.

The same line of reasoning, and the same method of comparison may be used for slope or plane haulages, elevators, etc., where the ropes operate in definite cycles, and where their production can be accurately measured and recorded.

WASH BELTS IN CONTINUOUS FILTERS

In *Chemical and Metallurgical Engineering* for October G. W. O'Keefe discusses the washing of the cake on continuous filters. The author says that it is fundamental to the method of cake washing on continuous filters that the wash water, percolating through the cake, displaces the strong liquor. This is in contrast with the scheme of lowering the gravity by dilution as is the practice in countercurrent decantation methods. Furthermore, the opportunity for obtaining a displacement wash of the cake is far greater with continuous filters than in plate-and-frame filter presses. In these units the deposited cake is seldom uniformly resistant and when washing is through the frames from alternate plates, this unequal resistance to flow is accentuated.

Theoretically, there is a better opportunity for true displacement wash in pressure- or vacuum-leaf filters, for the cakes are submerged in the wash water so that every square inch of cake surface is completely wetted. Practically, the pressure-leaf filters can obtain a displacement only in proportion to the personal efficiency of the operator. If he fails to shut off the filtering or loading cycle before the adjacent cakes touch each other, he creates unequal resistance to the passage of the wash water and depreciates the efficiency of his cake washing. If he fails to hold enough pressure in the filter while draining back the unfiltered slurry, he will slough off some of the deposited cake and his washing efficiency is lost. If he uses too high a pressure in draining the excess, he endangers his washing efficiency by dewatering the upper part of the cake even to the point of cracking the cake. Continuous filters suffer none of these drawbacks provided the point of application of the wash water is correct. To delay the application until cake shrinkage has set in fails in correctly applying the wash water. Failure to supply sufficient water so that the cake is partly dewatered during the washing cycle is likewise erroneous.

There are instances of materials filterable on continuous filters that present so high a resistance to the percolation of wash water that the restricted washing time possible does not provide for sufficient passage of water through the cake. Continuous filters applied to this class of work should operate in a countercurrent wash system, repulping the cake from one filter and refiltering it on a succeeding filter. For this discussion the author limits himself to those materials that filter readily and tend to form cakes which crack readily on dewatering or are of a granular nature.

With the cracking type of cake most of the wash water goes through the cracks, and high wash-water consumption with inadequate removal of soluble materials results. A special washing and compressing belt has been used with excellent results in overcoming this difficulty. Cake compression is vitally important in this operation as it densifies the cake and gives more uniform stream lines for the displacement wash. In a phosphate plant the high-grade residue has been washed better than with presses, and using far less wash water. Considering that the Baume of the liquor handled ranges from 30 to 40°, the results are excellent. In washing such a cake the wash-water consumption varies from 7 to 9 lb. of wash water per lb. of dry cake.

Granular cakes present a slightly different problem. With such a cake the percolation of wash water is very rapid. To obtain uniform wash under these conditions is far from easy. With the quantity of wash water required, it is impossible to prevent guttering of the cake in a manner similar to that obtained in crack-forming cakes. Again the wash belt lends itself admirably to the washing. On such types the quantity of wash water is usually less. Liquor of 7° Be. has been washed to 0·1% soluble in the cake with from 3 to 5 lb. of wash water per lb. of dry cake.

For material more restrictive to the flow of wash water or requiring the least possible soluble matter left in the cake, the countercurrent, two-filter wash is used with repulping between the filters. This system is especially attractive where it is desirable to keep up the Baume of the vented liquor. In this case it is customary to fractionate the liquors from the last filter. The stronger or first liquor fraction is used as a wash on the first machine and the second or weaker fraction is used to repulp the cake from the first filter. Fresh water is used, of course, on the final filter. Wash-water consumption with this type of material and on such a filter layout usually runs from 2 to 3 lb. of water per pound of dry cake.

There are also certain classes of precipitates that absorb or occlude the mother liquor. Such materials require special handling to make the soluble matter available. Subjecting the repulped cake to vigorous agitation decreases the particle size and makes it possible to remove the soluble by displacement washing. Numerous filtrations and repulpings do not appreciably lower the soluble matter in such precipitates. Only proper physical treatment of the discharged cake will insure satisfactory washing.

Comparative tests have been run with and without the belt and it has been shown that the belt makes it possible to wash effectively with the same quantity of wash water, even when half the soluble is left in the cake. The cake is also considerably drier and the vacuum pump requirements less by many cubic feet of pump displacement.

In conclusion, the writer has proved that continuous filters equipped with wash belts can handle many of the products which in the past have not been efficiently washed on automatic filters. His recent experience indicates an increasing field for the application of continuous filters in obtaining better washing efficiency than was possible with previously-used filters of the intermittent type.

MONASHEE CREEK, BRITISH COLUMBIA

Early placer mining history in British Columbia is recalled in the course of an article appearing in the October issue of the *Canadian Mining Journal*, where C. E. Cairnes describes the Monashee Creek placers. The author deals with the history of the workings, the topography of the country, the bench deposits, and the bedrock geology, going on to deal with the deposits themselves. He says that placer gold has been found in the creek gravels for many miles above the mouth of the Monashee Creek. The principal deposits have, however, been discovered within a distance of 3½ miles or so above its junction with Cherry Creek. Farther up stream, within the next 2 or 3 miles, attempts have been made to work the creek gravels as well as some remnants of bench deposits, but without any considerable success.

Most of the placer gold, amounting in all (so far as records show) to $100,000 or more, has been won from the creek gravels, and these have been mostly exhausted of their gold content, except immediately above the mouth of Monashee Creek. More recent work, commencing 10 years or so ago, has been chiefly concerned with investigating the bench deposits flanking the valley bottom. This work has been mainly confined to a section lying within 1,500 and 7,500 ft. of the mouth of Monashee Creek. Operations have involved :—(*a*) The excavation of pits in the bench gravels on the west side of Monashee Creek ; (*b*) the projection of an exploratory adit along the course of a late-glacial, auriferous channel of Monashee Creek ; (*c*) the investigation, by an adit, shaft, and surface workings, of a limited area of bench gravels on the west side of the creek about three quarters of a mile nearer the mouth ; (*d*) the drilling of a number of test holes ; and (*e*) the testing, by a series of drill-holes, of a considerable area of creek bottom land immediately above the junction of Monashee and Cherry Creeks.

An important feature connected with the history of Monashee Creek is that, though its present course corresponds in a general way with its position in late pre-glacial times, in places it has swerved from its old channel. It was along this channel that most of the placer gold is believed to have been deposited. During the glacial period much of these pre-glacial stream gravels were doubtless swept from Monashee valley and lost to the area. Their contained gold, however, by virtue of its great weight, would not have been transported to the same degree, and, though much of it would have been shifted by the advancing ice from the upper, and more confined sections of the valley, the greater part of it is believed to have settled in the lower-lying, broad portions of the valley along a principal channel, or possibly channels, carved by the advancing ice and subsequently modified by glacial streams which were particularly large and active during the period of ice retreat. Doubtless an important re-concentration of gold values was effected by such streams whose channel or channels were otherwise occupied by a great volume of glacial debris in the form, chiefly, of water-worn gravels and sands. Post-glacial stream erosion has, in turn, been able to effect a further concentration of this placer gold along those sections of Monashee valley where the present course of the creek corresponds closely with the course of a late-glacial channel. Where, however, the present stream course has been developed to one side or other of such a channel, important placer deposits may yet be found by tracing the course of the channel beneath its protective covering of drift.

The future of placer mining on Monashee Creek may be said to be restricted to the outcome of operations between its mouth and the junction of Heckman (Fall) Creek. Ample water supply is readily available for placer operations. When visited in 1929, Fales and Willoughby were employing water flumed from Heckman Creek. For more ambitious projects this water supply could be supplemented to any desired extent by the construction of a flume, about a mile and a half long, from Monashee Creek to connect with the Heckman flume.

In conclusion, it may be stated that the results of recent exploratory and development work in the immediate vicinity of Monashee Creek are distinctly encouraging and lend a new lease of life to a placer camp whose interest has been generally regarded as connected with its past history rather than its future prospects.

Aerial Surveying.—In a paper appearing in the *Bulletin* of the Institution of Mining and Metallurgy for October Donald Gill deals with the aerial survey in relation to economic geology. The paper covers the technical details of such surveys, their cost, and the interpretation of aerial photographs by the geologist and then goes on to discuss the aerial view and geological inference from the air. The use of such work in various countries is briefly reviewed by the author, who concludes with a survey of the future possibilities of the method. He says that aerial geology may be said to have "arrived" for the following types of work and in the localities named :

(1) Prospecting for oil—Western U.S.A.

(2) Route-finding and elimination of unpromising areas by visual reconnaissance—Canada.

(3) Geological mapping—Canada.

(4) Reconnaissance geological mapping by visual reconnaissance in country where the geology is not too complex—Morocco.

(5) Mapping ancient drainage systems—Uganda.

The extension of the practice of aerial geology to similar kinds of work in other countries is probably only a question of time, of a change in the business situation permitting a resumption of prospecting and of publicity for results achieved.

Aerial geology has been attempted for reconnaissance geological mapping (in conjunction with prospecting) in plateau countries of deep residual soils, where the co-operation of the ecologist will be necessary to achieve results. The author is convinced that this is a fit subject for research by some strong organization able to bear the considerable cost and willing to have patience if the desired criteria are not established in a few weeks. The lines for such research have been indicated by the ecologists but may need some modification at the geological end.

Apart from its use in Canadian prospecting, aerial geology does not yet seem to have interested the mining industry. The author, as a mining man rather than as a geologist, has been interested in the possibilities of aerial geological methods for several years and has formed the opinion that such methods could, in certain circumstances, be of definite aid in the close search for mineralization. The idea involved is the same as that involved in the selection of "promising" areas in Canada, but with the addition of the desire to locate "especially promising" areas within the "promising" ones. The modern search for mineralization, whether called "scientific prospecting" or "commercial geology," is generally an attempt to follow-up, as quickly and certainly as possible, some known or suspected "locus" of mineralization. When the "locus" has been traced, intensive methods (geophysics, drilling, or making holes in the ground) have to be employed.

It is in the work of tracing the locus of mineralization along the surface that aerial geology should be tried by the mining industry, as a speeder-up of the ground-geologists' work, in much the same way that it has been employed in California in oil-finding. The author considers it unnecessary to go into minute detail, since the forms taken at the surface by the various "pointers" toward mineralization vary so much from district to district. It may be said, however, that many of them can be recognized (and grouped together with the aid of the "aerial view") very much more easily from the air than on the ground, in country that is at all favourable to geological interpretation from the air. This is a field for aerial photography rather than for visual reconnaissance, and for close co-operation between the aerial and the ground-work.

What is suggested in the paper is nothing different from the present practice of the commercial geologist, He is merely offered a new tool with which to sharpen his perception. This tool cannot be used in all mining fields, but there are many in which its use deserves to be developed.

Pecos Concentrator, New Mexico.—Selective flotation methods as applied to mixed lead-zinc-copper-gold-silver ore at the 600-ton capacity concentrator of the American Metal Co., at Tererro, N. Mex., are described by H. D. Bemis in Information Circular 6605 of the United States Bureau of Mines. The mill treats sulphide ore containing pyrite, sphalerite, galena, chalcopyrite, marmatite, chalcocite, bornite, argentite, and proustite. The gangue minerals are chiefly mica, quartz, tourmaline, and hornblende. The feature of the milling practice used is the separation of the mica by flotation methods preliminary to the separation of the lead, copper, and zinc minerals.

The ore is crushed to 1½-in. size at the mine and delivered to the concentrator by an aerial rope-way. It is ground to 2·2% plus 65 mesh and 80·8% minus 200 mesh by three ball-mills operating as separate units, each ball-mill being in closed circuit with one duplex drag classifier. The classifier overflow pulps from the three grinding units are mixed and divided equally between two 3-stage flotation circuits. The first stage produces mica concentrates by means of roughers and pneumatic type cleaners. Cresylic acid is the only reagent added to this circuit. After conditioning the mica tailings the second stage of flotation produces lead concentrates ; a 16-cell machine for each of the two lead circuit units serves as both rougher and cleaner. The reagents used in the lead circuit comprise lime, zinc sulphate, cyanide, and xanthate ; sufficient cresylic acid remains in the mica tailings pulp for the operation of the lead circuit. The tailings of the lead circuits, after conditioning, are fed to the third flotation stage which produces zinc concentrates. Each of the zinc circuit units is equipped with roughers, cleaners, and air-lift type scavenger machines. The reagents used in the zinc circuits are lime, copper sulphate, xanthate, and pine oil. The mica concentrates are discarded with the general mill tailings; the lead and zinc concentrates are thickened and further dewatered by filters.

For the year 1930 the heads contained 4·93% lead, 15·41% zinc, 0·83% copper, 3·37 oz. of silver, and 0·107 oz. of gold per ton. The lead concentrates averaged 37·81% lead, 13·47% zinc, 4·02% copper, 19·98 oz. of silver, and 0·768 oz. of gold per ton. Recoveries in the lead concentrates amounted to 81·97% of the lead, 52·02% of the copper, 63·43% of the silver, and 76·89% of the gold. The zinc concentrates averaged 54·45% zinc, 1·0% copper, 1·63% lead, 3·05 oz. of silver, and 0·036 oz. of gold per ton. Recoveries in the zinc concentrates were 84·64% of the zinc, 28·99% of the copper, 21·73% of the silver, and 8·06% of the gold. Milling costs for the year 1930 were $1·19 per ton of ore treated.

Lead-Zinc Concentrator at Kellogg, Idaho. The selective flotation treatment of lead-zinc ores as carried on at the 300-ton capacity Page concentrator of the Federal Mining and Smelting Co. is described by G. S. Price in Information Circular 6590 of the United States Bureau of Mines. The ores treated consist of intimate mixtures of lead and zinc sulphides in a quartzite gangue; accessory minerals are pyrite, siderite, calcite, and tetrahedrite. After crushing to ¾-in. size by jaw crusher, cone crusher, and rolls, the ore is ground to 1·7% plus 65 mesh and 72% minus 200 mesh in two stages of ball-mills, the latter operating in closed circuit with a drag classifier. The overflow pulp of the drag classifier is treated in mechanically agitated rougher machines and pneumatic cleaners of the lead circuit; the latter produces finished lead concentrates and tailings which are further treated in mechanically agitated roughers and pneumatic cleaners of the zinc circuit. Flotation reagents used in the lead circuit comprise zinc sulphate, aerofloat, and cresylic acid; those used in the zinc circuit are copper sulphate, xanthate, and pine oils.

For six months of 1931 the mill heads contained 10·95% lead, 2·79% zinc, and 4·32 oz. of silver per ton. The lead concentrates averaged 70·8% lead, 6·9% zinc, and 27·2 oz. of silver per ton; the zinc concentrates averaged 51·3% zinc, 3·9% lead, and 5·3 oz. of silver per ton. The recoveries were 91·5% of lead, 92·6% of silver, and 55·0% of zinc. Concentrator costs for six months of 1931 amounted to $0·86 per ton of ore treated.

Waite Mine Geology.—In the *Canadian Mining and Metallurgical Bulletin* for October J. E. Gill and N. R. Schindler deal with the geology of the Waite-Ackerman-Montgomery property, Duprat and Dufresnoy townships, Quebec. Their paper concludes with a summary which is reproduced here. The authors say that the Waite group covers an area of 1,284·3 acres. This area is underlain by acid and basic volcanics cut by a complicated succession of intrusives—mainly dykes. The intrusives are separable into three, or possibly four, series, believed to differ widely in age. The volcanics were gently folded, probably before the intrusion of series 2, and were much disturbed locally by the intrusions. Two sets of faults are recognized: One, the earlier, with steep dips and dominant strike slips; the other, with dips of low angle and overthrust movements. Information at hand indicates that both sets came into existence shortly after the intrusion of the quartz-diorite dykes and before the formation of the ore-bodies. The ore is considered to have formed through the action of solutions derived from a deep-seated mass genetically related to the Dufault Lake granites. It thus appears that the faulting probably occurred just before or during the intrusion of the Dufault Lake granite, and that the ore formed just after the intrusion of the granite.

The known ore consists of sulphide lenses arranged in a stack near one of the high-angle faults. The reason for this arrangement is believed to be, in the main, structural. The details of the structural set-up in the vicinity of the ore-bodies are, however, only partially known. The textural relations of the sulphides indicate that they were deposited during a single period of mineralization. There is no evidence to show that the earlier existence of any one of the sulphides was essential for the formation of any other.

Experience in the district to date indicates that faults or massive igneous bodies so placed as to cause stagnation of rising solutions mark out favourable ground for ore occurrence. Areas underlain by volcanics which show considerable amounts of secondary quartz with chlorite and pyrite should be carefully investigated, especially if found in conjunction with favourable structures.

Milling Practice at Walkermine, California.—Milling methods as practised in the concentrator of the Walker Mining Co. are described by M. R. McKenzie and H. K. Lancaster in Information Circular 6555 of the United States Bureau of Mines. The concentrator has a maximum capacity of 1,700 tons per day, and treats ore containing about 1·70% copper in the form of chalcopyrite by flotation methods. The mill feed is crushed to minus 1-in. size by two stages of jaw crushers followed by two stages of rolls; the latter each operating in closed circuit with trommel screens. The minus 1-in. material constitutes the feed to the grinding sections of the concentrator.

The concentrator is divided into four sections for grinding and flotation operations. Each section is equipped with a ball-mill which operates in closed circuit with a drag classifier and grinds the minus 1-in. feed to 12% plus 48 mesh size for flotation. The classifier overflow pulps of the four mill sections are mixed and then distributed to four flotation units, each of which is equipped with two rougher machines operating in parallel followed by two cleaners operating in series. Final concentrates are produced in the second cleaner cell and all middling froths are returned to the heads of the rougher machines. The rougher machine tailings from all units are combined and treated in scavenger cells; the latter produce waste tailings and middlings which are returned to the head of the flotation circuit. Reagents used comprise lime, potassium ethyl xanthate, and pine oil. The final concentrate pulps are thickened and further dewatered by filter.

For the period June to November, 1930, the concentrator treated an average of 1,580 tons of ore per day, and produced concentrates, which contained 24·00% copper, 9·9 oz. of silver, and 0·49 oz. of gold per ton. The concentratation ratio averaged 15·57 tons into 1; the recovery of copper amounted to 91·21%.

SHORT NOTICES

Cut-and-Fill Mining.—M. J. Elsing discusses the cost of cut-and-fill mining in the *Engineering and Mining Journal* for October.

Concreting Tunnels.—Some notes on concreting a haulage tunnel in the Desiré mine at Pilgrims Rest are given by H. C. F. Bell in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for August.

Queen Street Tunnel, Johannesburg.—E. J. Hamlin and W. Pryce-Prosser describe the construction of the Queen Street sewage-disposal tunnel, Johannesburg, in the *Journal* of the South African Institution of Engineers for October.

Spoil Removal in Tunnel Construction.—The third part of an article on the new water-supply tunnel for New York City, appearing in the *Engineer* for October 21, deals with mucking arrangements.

Pneumatic Stowage.—Pneumatic stowage in Lancashire coal mines is described by W. J. Charlton in *Colliery Engineering* for November.

Headframes.—L. Eaton discusses headframe construction and design in the *Engineering and Mining Journal* for October.

Winding.—The influence of mechanical braking on winding equipment design is discussed by J. F. Perry and Dr. D. M. Smith in the *Colliery Guardian* for October 7.

Winding Plant at Broken Hill.—A description of new winding equipment fitted with improved Ward-Leonard controls intended for installation at mines in the Broken Hill area, New South Wales, appears in the *Engineer* for October 7.

Fan Pressures.—In *Colliery Engineering* for November W. E. Cooke discusses the measurement of fan pressures.

Quarrying Phosphate.—R. A. Sutherland describes the quarrying and handling of phosphate rock on Christmas Island, in the Indian Ocean, in the *Chemical Engineering and Mining Review* of Melbourne for September 5.

Aerial Ropeways.—In the *Iron and Coal Trades Review* for October 21 D. MacKinnon describes the changing of the rope on an aerial ropeway at Ardenrigg colliery, Airdrie.

Alluvial Sampling.—The manner in which placers in the Californian desert were sampled by the use of well-digging equipment is described by M. D. Draper in the *Engineering and Mining Journal* for October.

Screen Testing.—The standard hand method for the screen testing of ores approved by the American Standards Association is published in *Mining and Metallurgy* for October.

Mill Pumping Problems.—M. J. Reed and L. H. Morrison discuss the effects of hydraulic head on plant pumping in *Chemical and Metallurgical Engineering* for October.

Cyanide Solution Activity.—In the *Journal* of Chemical, Metallurgical, and Mining Society of South Africa for August W. E. John and E. Beyers discuss the efficiency of the electrical method of measuring the activity of cyanide solutions.

Flotation.—O. D. Welsch discusses the part played by chemical activity in flotation processes in the *Engineering and Mining Journal* for October.

Preferential Wetting of Solids.—In *Industrial and Engineering Chemistry* for October N. S. Davis and H. A. Curtis give the results of a study on the preferential wetting of solids by liquids.

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.*

6,917 of 1931 (380,428). British Thomson-Houston Co., Ltd., London. Steel and other carbon-containing metals are enveloped during metallurgical operations in an inert or de-carburizing gaseous atmosphere, either to protect the metals from oxidation or to preserve or modify the carbon content of the metal.

12,167 of 1931 (379,322). International Nickel Co., Inc., New York, and C. A. Knittel, Port Colborne, Ontario. Nickel-bearing solutions containing copper and iron are treated with nickel powder in order to effect a cementation of dissolved copper and to reduce the hydrogen ion content of the liquor to a point at which the iron can be precipitated directly as hydroxide by treatment of the solution with air alone.

15,139 of 1931 (379,331). A. A. Johnson, Stockholm, and B. M. S. Kalling and C. Von Delwig, Avesta, Sweden. Sulphides of non-volatile metals are directly reduced to the metal by heating the sulphides without fusion with oxides or compounds of calcium, magnesium, or barium, these compounds being wholly or partially converted to sulphide.

17,043 of 1931 (380,493). Berzelius Metallhutten G.m.b.H., Duisberg-Wanheim, Germany. Metals such as tin, lead, antimony, or bismuth, or alloys thereof, are recovered from substances containing volatile metals, such as arsenic, cadmium, or zinc, by a reducing treatment at temperatures at which the alloy or metal to be recovered—but not the residues of the charge—is melted during reduction.

22,037 of 1931 (380,215). W. Husband and I. Bowen, Treherbert, Rhondda Valley, South Wales. A device for preventing mine cages from falling down the shaft, which consists of a spring-operated wedge that causes engagement of brake blocks with the lift guides in the event of the rope breaking.

23,156 of 1931 (380,570). Siemens and Halske A.-G., Berlin-Siemensstadt, Germany. Manganese added to copper-beryllium alloys is found to improve the rate of expansion and to assist in the retention of the peculiar physical properties of the alloys at temperatures above 300° C.

24,584 of 1931 (379,855). E. Feuer and P. Kemp, Vienna. Zinc white is produced from metallic raw materials by vaporizing the zinc in one region of the furnace by means of hot gases which contain no constituents that will oxidize the zinc or re-act directly with it, the zinc vapour being carried forward into the oxidation region.

32,386 of 1931 (380,297). J. Leemans and the Société Générale Métallurgique de Hoboken, Belgium. Metallurgical converters having an outlet flue of inverted U-shape moving with the converter and distinguished from the opening for charging the furnace, the flue having one limb opening into the converter roof and being closed during the working phases, thus forming a constant tight-joint connexion between the converter and the chimney.

32,883 of 1931 (380,653). J. L. Barber, Liverpool, and F. H. Sharpe, Via Arequipa, Peru. Argentiferous manganese ores are first treated with SO_2 to convert the manganese dioxide to sulphate, the residue being then treated with hypo to remove the silver, or to remove silver and copper.

34,935 of 1931 (379,587). INTERNATIONAL HYDROGENATION PATENTS CO., LTD., Leichtenstein. Catalysts for use in hydrogenation processes.

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.

A Textbook of Physical Chemistry. Vol. I—General Properties of Elements and Compounds. By J. NEWTON FRIEND. Cloth, octavo, 501 pages, illustrated. Price 24s. London: Charles Griffin and Co.

The A.I.M.E. Series. 5 vols. 1.—Technical Writing, by T. A. RICKARD. 2.—Choice of Methods in Mining and Metallurgy. 3.—A History of American Mining, by T. A. RICKARD. 4.—The Examination of Prospects, by C. G. GUNTHER. 5.—Mineral Economics. Price for series—before December 31, 1931, $10, after December 31, $12·50. New York and London: McGraw-Hill.

Handbuch der Geophysik. Band II, Lieferung 2—Der geologische Aufbau der Erde. By Dr. A. BORN. Paper covers, pp. 565–867, illustrated. Subscription price RM. 46, ordinary price RM. 69.

Elektrizität unter Tage. By Dr.-Ing. E. h. W. PHILIPPI. Paper covers, 191 pages, illustrated. Price RM. 15.80. Leipzig: S. Hirzel.

Eisen- und Stahllegierungen: Patentsammlung. By A. GRÜTZNER. Appendix to the "Metallurgie des Eisens" in Gmelins Handbuch der anorganischen Chemie. Paper covers, 308 pages. Price RM. 32. Berlin: Verlag Chemie.

A French-English Vocabulary in Geology and Physical Geography. By G. M. DAVIES. Cloth, octavo, 140 pages. Price 6s. London: Thomas Murby and Co.

List of Mines, 1931: Great Britain and the Isle of Man. Paper covers, 371 pages. Price 10s. London: H.M. Stationery Office.

Report of H.M. Electrical Inspector of Mines, 1931. Paper covers, 42 pages. Price 9d. London: H.M. Stationery Office.

Home-Grown Scots Pine: Forestry Products Research Bulletin No. 15. Price 5s. London: H.M. Stationery Office.

McConnell Creek, British Columbia: Report on the Placer Area. Bulletin No. 2 of the British Columbia Department of Mines. By DOUGLAS LANG. Paper covers, 17 pages typescript, illustrated. Victoria: Bureau of Mines.

Alberta: Report of the Research Council for 1931. Paper covers, 53 pages, with maps. Edmonton: University of Alberta.

Gold Coast Colony: Geological Survey Department Report, 1931–32. Paper covers, folio size. Price 2s. London: Crown Agents for the Colonies.

Tanganyika Territory: Geological Survey Annual Report, 1931. Paper covers, 49 pages, with map. Price Shs. 2·50. London: Crown Agents for the Colonies.

British Guiana: Lands and Mines Department Report, 1931. Paper folio, viii + 20 pages. London: Crown Agents for the Colonies.

Western Australia: Department of Mines Report, 1931. Paper covers, folio size, illustrated. Perth: Department of Mines.

Shaft-Sinking Practices and Costs. United States Bureau of Mines Bulletin 357. By E. D. GARDNER and J. F. JOHNSON. Paper covers, 110 pages, illustrated. Washington: Superintendent of Documents.

Gold Mining and Milling in the United States and Canada: Current Practices and Costs. United States Bureau of Mines Bulletin 363. By C. F. JACKSON and J. B. KNAEBEL. Paper covers, 151 pages, illustrated. Price 15 cents. Washington: Superintendent of Documents.

Furnaces and Flues: Removal of Soot by the Use of Salts or Compounds. United States Bureau of Mines Bulletin 360. By P. NICHOLLS and C. W. STAPLES. Paper covers, 76 pages, illustrated. Washington: Superintendent of Documents.

Accidents at Metallurgical Works in the United States, 1930. By W. W. ADAMS. Bureau of Mines Technical Paper 530. Paper covers, 36 pages. Washington: Superintendent of Documents.

Coal-Mine Accidents in the United States, 1930. Bureau of Mines Bulletin 355. By W. W. ADAMS, L. E. GEYER, and L. CHENOWETH. Paper covers, 114 pages. Price 10 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States. 1930—Part I, pp. 749–791, Ore-Concentration Statistics, by T. H. MILLER and R. L. KIDD. 1931—Part II, pp. 33–44, Carbon Black, by G. R. HOPKINS and H. BACKUS. Price each 5 cents. Washington: Superintendent of Documents.

Sands, Clays and Minerals. Vol. I, No. 2. Paper covers, 60 pages, illustrated. Price 5s. per annum. Chatteris, England: Algernon Lewin Curtis.

African World Annual, 1932. Paper covers, 240 pages, illustrated. Price 3s. 6d. London: African World.

COMPANY REPORTS

Glynn's Lydenburg.—This company was formed in 1895 and works gold-mining properties in the Pilgrim's Rest district of the Transvaal. The report for the year to July 31 last shows that 76,500 tons of ore was sent to the mill, where 31,025 oz. of gold was recovered, worth £131,446, the silver recovered bringing the total revenue up to £131,554, or 34s. 5d. per ton. Working costs amounted to £118,203, or 30s. 11d. per ton, leaving a working profit of £13,351, an improvement of £10,822 on the previous year's return. The expenditure on capital account during the year was £8,990. The ore reserves at the end of the year were estimated to be 330,970 tons, assaying 7·9 dwt. per ton, as compared with 316, 330 tons, averaging 8·7 dwt., at the end of the previous year. The introduction of all-sliming practice at the mill in June, 1932, has resulted in increased capacity for the plant as well as an improvement in gold recovery.

Zaaiplaats Tin.—Formed in 1908, this company has tin-mining properties in the Waterberg district of the Transvaal. The report for the year ended July 31 last shows that 23,535 short tons of ore was milled, 188 long tons of concentrates being recovered. In addition 4·5 long tons of concentrates was purchased, the tenor of the whole going 71·9% tin metal. The year's working resulted in a loss of £3,454, £2,979 being transferred from reserve account and a balance of £1,990 being carried forward. A policy of selective mining is in operation while further exploration is being done through the sinking of the Main Incline and Lease shafts.

Luiri Gold Areas.—This company was formed in 1928 and operates gold-mining properties in Northern Rhodesia. The report for the year to March 31 last shows that 2,475 tons of ore from the Matala Hill mine and 12,932 tons from the Dunrobin mine were treated in the Matala plant, the bullion recovered amounting to £52,793 (including £9,426 premium). The accounts for the year show a debit balance of £454, increasing the debit brought in to £13,294. From the beginning of April, 1932, to the end of June, when the plant was closed down, 4,338 tons of ore was treated, the bullion recovered amounting to £7,755, including premium.

Filani (Nigeria) Tin.—This company was formed in 1911 and works alluvial tin-bearing property in Northern Nigeria. The report for 1931 shows that 41½ tons of tin concentrates was produced, operations being much curtailed during the year under the quota scheme. Concentrates sold during the year realized £65 15s. 7d. per ton, against £83 9s. 6d. per ton in the previous year. Working costs at the mine amounted to £69 7s. 6d. per ton, the year's operations resulting in a loss of £432. The output for the year was won solely by hand labour.

United Tin Areas.—Formed in 1925 this company works alluvial tin properties in Northern Nigeria. The report for the year ended June 30 last shows that 189 tons of tin concentrates was produced, against 269 tons in the previous year, the average price realized for the output being £67 10s. 10d. per ton, against £60 18s. 2d. The costs have been reduced to £44 19s. 11d. per ton of 70% concentrates placed free on rail. The accounts, after allowing £2,303 for development expenditure and depreciation, show a profit of £1,382, reducing the debit balance brought in to £6,258. Work is at present confined to the Gurum River section, where values are good and the production costs low.

Consolidated African Selection Trust.—This company was formed in 1924 and has large diamond concessions in the Akim district, Gold Coast Colony. The report for the year to June 30 last shows that results were adversely affected by the diamond market, the reserve position being augmented by more than the year's output. Considerable areas of ground still remain undeveloped while prospecting has continued to yield favourable results. The accounts for the year show a credit balance of £86,562, the amount available, after allowing for the sum brought in, being £146,256. Of this amount, £10,000 was placed to reserve, £10,200 used for debenture redemption, and £74,933 absorbed in dividend payments (equal to 30%), leaving a balance of £51,123 to be carried forward.

Temoh Tin.—Formed in 1927, this company owns an alluvial tin property in the Batang Padang district, F.M.S. The report for the year to June 30 last states that it was considered advisable not to work the dredge but to dispose of the company's quota certificates. The accounts show a loss of £1,568, which, deducted from the sum of £9,227 brought in, leaves £7,659 to be carried forward.

Kampar Malaya.—This company, formed in 1927, operates alluvial tin property in the Kinta district, F.M.S. The report for the year to April 30 last shows that the dredge continued to operate until October 31, 1931, although it was idle for 41 days during that period in respect of voluntary restriction agreements. During this period the output amounted to 324 tons of concentrates, recovered at a working cost of £39 13s. 8d. per ton. From November 1, 1931, the company's quota was pooled with that of Southern Kampar Tin Dredging, Ltd. The accounts show a profit of £13,439, which, with the balance of £4,353 brought in and £2,705 reserved in excess for taxation, gives an available total of £20,497. Of this amount £2,675 has been absorbed in curtailment expenditure, £6,761 in the payment of a dividend equal to 4½d. per share, and £5,000 placed to depreciation reserve, leaving a balance of £6,061 to be carried forward.

Kinta Kellas Tin.—This company was formed in 1926 and operates alluvial tin property in the F.M.S. The report for the year ended March 31 last shows that 251 tons of tin concentrates was produced under restriction conditions, the output realizing £17,562, or £69 18s. 7d. per ton. The loss on the year's working was £2,786, while £6,065 has been appropriated for depreciation, so that, after allowing for the sum of £643 brought in from the previous account, there remained a debit balance of £8,208 to be carried forward.

Pari Tin.—This company was formed in 1922 and operates alluvial tin property in the Chemor district, Ipoh, F.M.S. The report for the year to June 30 last shows that mining work was confined to small tribute workings, the quantity of ore recovered amounting to 14·85 tons. Operations resulted in a loss of £106, which, deducted from the sum of £1,488 brought in, leaves a balance of £1,382 to be carried forward.

DIVIDENDS DECLARED

Broken Hill Proprietary.—1s. (Australian currency), less tax, payable November 16.

Great Boulder.—3d., less tax, payable December 6.

Kampar Malaya.—4½d., less tax, payable October 28.

Lake View and Star.—6d., less tax, payable December 1.

North Broken Hill.—1s., less tax, payable December 14.

Petaling.—4%, less tax, payable November 8.

Rawang Concessions.—6d., less tax, payable November 26.

Rio Tinto.—Pref. 2s. 6d., less tax, payable November 15.

St. John del Rey.—Pref. 1s., tax free; Ord. 9d., less tax, payable November 18.

Sons of Gwalia.—6d., less tax, payable December 15.

Trepca.—7%, less tax, payable December 13.

Trinidad Leaseholds.—1s. 6d., less tax.

NEW COMPANY REGISTERED

African Enterprises. — Private company. Capital: £100 in 86 "A" Ordinary and 14 "B" Ordinary shares of £1 each. Objects: To acquire mineral or other properties and to carry on the business of miners.