The Mining Magazine

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EDITORIAL

AN invitation to become the independent chairman of the committee set up to advise the Government on questions relating to copper arising from the Ottawa Agreements, tendered to Sir Leslie Scott by both producers and consumers, has been accepted.

THE series of valuable booklets published by the Science Museum in connexion with their exhibits has been added to by a volume [1] on pumping machinery. This is in the nature of an introduction and deals with the history of pumps generally. The book is a welcome contribution to the literature on applied science.

AT a demonstration of oil-electric locomotives at the Scotswood works of Messrs. Armstrong Whitworth and Co., at Newcastle last month, it was stated that the Diesel-electric coach referred to in our issue for December, 1931, had recently completed six months' running on a L.N.E.R. service. This coach had covered 25,000 miles without a hitch at an all-in cost of less than 1d. per coach mile, something far cheaper than could be obtained by any other system.

A SCHEME which has in view the manufacture in this country of basic Bessemer steel—to which reference was made in the MAGAZINE for June last—appears about to be realized through the agency of the Bankers' Industrial Development Company. An area of 26,000 acres in the Northamptonshire ironfield—said to cover 500,000,000 tons of suitable ore reserves—is to be developed, while plant for the production of steel and the manufacture of tubing is to be erected at Corby, near Kettering.

IN the August issue of the MAGAZINE, in the course of a review of a report by the Advisory Committee for the Metalliferous Mining and Quarrying Industry, it was stated that proposals for a drainage scheme for the Camborne-Redruth area had been approved in principle. At the annual dinner of the Royal Geological Society of Cornwall last month Mr. R. Arthur Thomas made further reference to the project, expressing the hope that the Government might see its way to implement the recommendations of the committee.

SINCE 1922, when the Shaler Memorial Expedition visited the Transvaal to study the great Bushveld Complex of igneous rocks, the attention of geologists has been directed to the field by the notable discovery of platinum deposits in the Bushveld norite towards the end of 1924. Many noted scientists have contributed to the elucidation of the history of the Bushveld cycle of igneous activity and all their work has now been clarified and co-ordinated by Dr. A. L. Hall, who publishes his account of the Complex in Memoir No. 28 of the Union Geological Survey. This memoir has been completed since Dr. Hall retired from his position as Assistant Director of the Survey in February last and it will be agreed that his latest work will be of great value in the solution of many unsolved problems in the geological history of the Union.

The Air Arm

The Institution had one of its busy months in November, members being invited to attend two meetings. The first—the ordinary monthly gathering—met to discuss Mr. Donald Gill's paper on "Aerial Survey in Relation to Economic Geology," which had been published in the October *Bulletin* and of which an extract was given in the last issue of the MAGAZINE. The second was an extra general meeting, convened to enable members to hear Major Bernhard Day, in this country on a visit, discourse on "Prospecting and Mining for Gold, Silver, and Radium at Great Bear Lake, North West Territories, Canada." Much has been heard within the last few years of the part that air transport has played in the opening up

[1] "Pumping Machinery." Part I—Historical Notes. Price 2s. 6d. London: H.M. Stationery Office.

of this out-of-the-way part of the Dominion, so that both meetings dealt with somewhat related subjects and much was heard of the new tool placed in the hands of the explorer and mining engineer by the rapid advance of air-transport methods.

Dealing first with the principal meeting, Mr. Gill, as indicated by the title of his paper, is particularly concerned with the application of aerial methods to economic geology and emphasizes the useful part that aerial reconnaissance can play as a time-saving element in exploratory work. He is inclined to be disappointed that so far the mining man has not made the best possible use of the aerial attack and has been slow to realize the potentialities of aerial geological methods, especially in the search for mineralization. The methods used in Canada for the location or selection of promising areas are described and the author points out how intensive work has made it possible to find what are regarded as especially promising areas by the fixation or location of important features —structural, ecological, or topographical— which can afterwards be more closely examined. It is the view of the author that aerial reconnaissance is the time saver, although, as he indicates, the intelligent examination of aerial photographs by an experienced man using stereoscopic apparatus can often supply important clues to the solution of structural geological problems. In other words, the commercial geologist is equipped with a new tool—a tool which cannot be employed in all mining fields, perhaps, but which has its definite sphere of usefulness. In the brief introduction given by the author on the evening of the meeting these ideas were expressed, reference being made to work in the Transvaal and other parts of Africa, and he is to be congratulated on the fact that those speakers who followed him were in a position to confirm and amplify his views. The discussion was opened by Professor P. G. H. Boswell, who, while emphasizing that his experience had been principally in oblique work, in contradistinction to the vertical methods used in the usual aerial survey, was profoundly impressed by the possibilities of aerial surveying. This impression he was able clearly to impart to his hearers by means of a series of lantern slides, all of which contained much of interest and helped to explain the method of attack. Professor Boswell was followed by Mr. N. E. Odell, who, also with the aid of a remarkable series of slides, illustrated work of this nature undertaken by the recent Grenfell-Forbes expedition in North-East Labrador. Professor L. Hawkes, in his turn, referred to his work in Northern Rhodesia, undertaken for the Colonial Office, and his remarks served to show in what respects the method is useful and to indicate what are its limitations. Work at the Wanderer mine, in Southern Rhodesia, was then described by Mr. Robert Annan, while Major Hemming, of the Aircraft Operating Company, who followed, gave some particulars of the preparations to be made before an aerial survey can be undertaken. Professor V. C. Illing and Mr. R. Bourne also took part in the discussion, all of which had served to show that if aerial work is the primary step the confirmation of detail must be undertaken on foot—the airman cannot yet replace the geologist or the prospector, although he certainly can help him. Many remarks of the author and the other speakers were still further illustrated at the meeting by an exhibition of stereoscopic apparatus and photographs, as well as an aerial camera.

Survey work in the North West Territories of Canada has received wide attention, in view of the discoveries of radium at Great Bear Lake and the prospect of hearing some first-hand information of this region attracted a good number to the special meeting, which was held at the Institution of Mechanical Engineers. Major Day, after introduction by the President, dealt, in the course of his lecture, with the history of the discovery of the mineralized areas of the Coppermine River and Great Bear Lake, especially referring to the methods of prospecting and mining employed in the region. A series of cinematograph films served to bring home to his audience the conditions under which the lecturer and his colleagues had been working and to give a clearer conception of the nature of the country than could possibly be given in words. The air arm was again to the fore and the photographs displayed by Major Day were such as to give striking confirmation of many of the points which had been made by Mr. Donald Gill in his paper. A number of selected specimens of silver and radium ore were exhibited by the lecturer, whose discourse was intended to interest the British capitalist in the possibilities of the Canadian mineral industry. So far as justification for this interest is concerned, however, it has to be remembered that the radium deposits of Great Bear Lake have

still to be proved at depth and much must be done before the field can compete seriously with the virtual monopoly of the Belgian producers. On the other hand, if not much is known of the radium deposits of Great Bear Lake it is equally true that the size and potentialities of the deposits in the Belgian Congo are also unknown, although it is generally recognized that they must be of an extensive nature.

The Kakamega Goldfield

The discovery of a new goldfield is always a matter of importance, but at the present time, when the scarcity of the metal is being blamed for most of the ills with which we are afflicted, a new find not unnaturally receives marked attention. At the end of 1931 news reached this country of gold discoveries in Northern Kavirondo—a stretch of country in Kenya north of the Kavirondo Gulf, on the Victoria Nyanza—and in March last we recorded that there had been a mild rush of prospectors to the Yala River, one of the streams draining the area. The importance of the discovery was on this particular occasion soon realized by the authorities and in April last Sir Albert Kitson left for Kenya to inaugurate a Geological Survey and to report on the new field. At that time, too, the richness of some of the alluvial discoveries was attracting others to the area and search for the parent reefs was commenced. It will be recalled that at the last annual meeting of the Tanganyika Concessions it was stated that the company had acquired an interest in the Eldoret Syndicate, which held an important group of claims in the district, while other companies were known to be in the field, and since then the Tanganyika Concessions has applied for the sole prospecting rights over an area of 5,900 square miles. The views of the workers—mainly agriculturists attracted from their farms in a time of depression—are evidently against the granting of a concession covering such a large area, the contention being that the prospecting rights of individuals should be preserved, and a petition has been extensively signed in Kenya praying the Legislative Council to advise the Governor to withhold his consent to the application. At this stage Sir Albert Kitson's interim report was published and its tone—generally optimistic in character—has rendered feeling on the question even more acute.[1]

In pre-war days there was considerable prospecting activity in Southern Kavirondo between the Gori and Myunyo Rivers and even in 1929 lode mining on a small scale was being carried on there. In the report [2] of a reconnaissance made in this area in 1930 Mr. E. J. Wayland once again called attention to the importance of the N.W.–S.E. line formed by the direction taken by the Nile below Nimule and continued by the course of the Assua River and the Nandi escarpment, a zone characterized by extensive shattering and shearing, and he associated the gold occurrences in Southern Kavirondo with this feature of East African structure. In May last, in the course of a review of some notes by Dr. Groves on the new Kakamega discoveries, the MAGAZINE called attention to the fact that the finds were located on the same line. In Southern Kavirondo the gold is associated with pyrite in waxy quartz reefs, the country consisting mainly of intensely-sheared granite-porphyries closely resembling slates in appearance. Sir Albert Kitson states that in the Kakamega field the reefs have been found in phyllites, slates, grits, conglomerates, syenite, diorite, sheared dense porphyry, felspar-porphyry, and granite, the greatest number of known occurrences being in threads, thin veins, and reefs of quartz along foliation and bedding planes of the rocks and in fracture planes. He remarks that the rarity of outcrops on the greater portion of the field, owing to the thickness of the soil capping, has compelled the adoption of special measures of prospecting, the use of soil-augers having been particularly developed. This, as he points out, has revealed one of the most striking features of the area—the great number of sources from which the alluvial gold has been derived.

It is apparent from Sir Albert's report that many small, rich alluvial deposits have been found and that hasty working has brought affluence to the fortunate few. Nevertheless, it cannot but be felt that the inexperienced many are bound to lose their

[1] Interim Report on the Kakamega Goldfield, Kenya. By Sir Albert E. Kitson. Price 1s. Nairobi: Government Printer.

[2] Report on a Geological Reconnaissance in Southern Kavirondo. By E. J. Wayland, with appendices by Dr. A. W. Groves. Price 2s. 50 cents. Nairobi: Government Printer.

stake in workings not rich enough for exploitation. Tales of the prospectors' activities have revealed some of the pitiful work now in progress, a blind faith in the efficacy of divining appliances for prospecting purposes being one result of the feverish haste to locate the elusive reefs. It is important to mark, therefore, that the Miners' Association recognizes the need for the presence in the area of some strong financial organization, experienced in the development of mining fields in Africa, in order that the mineral resources may be adequately explored. The extensive soil blanket, for example, needs careful work—possibly exploration by geophysical methods. It is to be hoped, therefore, that some means may be found by which the rights of the individual may be protected, while adequate development of the area is assured, for the field is evidently of sufficient promise to warrant a thorough investigation.

The Anglo-Persian Oil Dispute

The business world has been profoundly stirred during the past month by the trouble which has arisen between the Anglo-Persian Oil Company and the Persian Government. At the end of November the authorities in Persia intimated to the company that the D'Arcy concession, granted to Mr. W. K. D'Arcy in 1901 for 60 years and taken over by the Anglo-Persian Oil Company in 1909, had been annulled. By this step, which, it is stated, will not interfere at present with the work of the operating company, the Persian Government has indicated its dissatisfaction with the course of the negotiations in which it has been engaged with the company for some years. It may be recalled that the terms of the original concession gave Mr. D'Arcy the exclusive right to search for and deal with petroleum, asphalt, and ozokerite throughout the Persian Empire, with the exception of five provinces bordering on the Caspian Sea—Azerbadjan, Ghilan, Mazendaran, Asdrabad, and Khorassan. The concessionnaire commenced work in the country in 1901 and struck oil in 1908, the Persian Government sharing none of the financial risks of this development period. Shortly afterwards the Anglo-Persian Oil Co., Ltd., was formed to acquire and work the concession and its active development has opened up the Masjid-i-Sulaiman and Haft Kel fields, about 100 miles from Abadan, on the Persian Gulf, where the company's refinery is situated, as well as the Naft Khaneh field, on the Iraq border. The payments made by the company to the Government constitute one of the major sources of revenue in the Persian budget, the total receipts up to the end of 1931 having been approximately £10,000,000, while it is stated that the annual cash expenditure by the company in Persia is in the neighbourhood of £1,500,000. The course of the dispute cannot fail to be of interest to mining men and the position seems worthy of closer examination.

From what has so far transpired, it is evident that the Persian authorities are dissatisfied with the reduced amounts they are now receiving in royalties. The text of the correspondence between the company and the Government recently published shows that ever since profits began to be earned there have been periodical disputes between the two parties as to the manner in which the Government's 16% share should be calculated. Agreement was reached in 1920, but in 1928 the question was reopened at the request of Persia and at the beginning of the present year a preliminary royalty contract was signed. This, however, has not been ratified in Teheran. The statement of royalties paid shows that in 1930 these amounted to £1,288,000, but in 1931 the sum due to the Persian Government was only £134,700, a figure which may have proved disconcerting to the Minister responsible for the compilation of the Persian budget, although the company had warned the authorities that bad trading conditions were likely to result in a heavy fall in profits and, consequently, in the amount of royalties likely to be forthcoming. The main point seems to be, however, that the concession agreement contained no provision for cancellation and the company refuses to recognize the legality of the annulment decree. The part to be played in the settlement of the dispute by the British Government is a difficult one, for it is something more than the protection of the interests of its nationals that is involved. Not only is the Government the trustee of the national holding of over £7,000,000 in the company's shares, but the oil used by the Navy is principally derived from this source. It is to be hoped, therefore, that the Persian authorities may realize that the course they have chosen to pursue is at variance with the ethics of international relationships.

REVIEW OF MINING

Introduction.—During the past month business has been largely influenced by the attitude of the United States with regard to the War debts question. The conference of copper producers in New York appears to have accomplished little and the present agreed cut to 20% of capacity seems likely to be continued.

Transvaal.—The output of gold on the Rand for November was 930,085 oz. and in outside districts 48,631 oz., making a total of 978,716 oz., as compared with 974,965 oz. in October. The number of natives employed in the gold mines at the end of the month totalled 219,024, as compared with 216,298 at the end of October.

It was announced early this month that all details had been agreed between the new company, East Daggafontein Mines, Ltd., and the Union Government and that the lease over the Farm Daggafontein No. 9 had been signed. East Daggafontein Mines has been floated jointly by the Anglo American, Central Mining, and New Consolidated Gold Fields groups and will have an initial capital of £350,000 in 10s. shares, of which 200,000 fully-paid shares will be allotted to Daggafontein Mines for a part of the claim area and for services to be rendered in the development of the new lease.

Last month an issue of 102,000 Brakpan shares at 50s. (South African) was made to existing holders. The new shares will not rank for the dividend usually declared this month.

Shareholders of West Rand Consolidated were informed last month of further important developments. In the South Shaft the Main Reef was intersected at 3,613 ft. below surface, the values disclosed averaging 8·2 dwt. over a stoping width of 63 in.

The report of Luipaard's Vlei Estate and Gold Mining for the year ended June 30 last shows a net profit of £63,676, against £44,829 in the previous year. Adding the credit balance of £23,362 brought in, there was an available total of £87,039, of which £35,271 was written off development account, £28,067 absorbed in the payment of a dividend of 12½%, and the balance of £23,701 carried forward. During the year 387,900 tons of ore was crushed, yielding 97,538 oz. of gold, worth £413,487, at a working cost of £362,608. The ore reserves at the end of the year were estimated at 1,095,400 tons, averaging 5·3 dwt. Arrangements have been made with the West Rand Consolidated Company whereby the latter will extend a deep-level drive from the 27th level into the Luipaard's Vlei property.

The accounts of the Consolidated Gold Fields of South Africa, Ltd., for the year to June 30 show a profit of £136,385, derived almost entirely from dividends on New Consolidated Gold Fields, Ltd., shares. After adding the balance of £59,114 brought in from the previous year and deducting preference dividends amounting to £133,638, there remained a balance of £61,861 to be carried forward.

Diamonds.—The report of De Beers Consolidated for the year ended June 30 last shows an income of £307,822 from the sale of diamonds, receipts from other sources amounting to £445,516, the total, added to the balance brought in, giving a gross revenue of £1,888,801. Expenditure totalled £895,819, leaving an unappropriated balance of £992,982 to be carried forward.

Southern Rhodesia.—The output of gold from Southern Rhodesia during October was 50,416 oz., as compared with 50,198 oz. for the previous month and 44,260 oz. for October, 1931. Other outputs for October last were: Silver, 8,423 oz.; coal, 39,337 tons; chrome ore, 825 tons; asbestos, 898 tons; mica, 1 ton; iron pyrites, 300 tons.

In the return of the Sherwood Starr company for the month of November it was stated that a portion of the new plant had been brought into action, somewhat disturbing the routine metallurgical treatment. Later advice was to the effect that the plant was running normally and that the January figures should show an increase in the tonnage crushed. Dislocation of the jasperlite ore-body between Nos. 10 and 12 levels has been accompanied by a local increase of valueless stibnite, which is temporarily affecting treatment.

The accounts of the London and Rhodesian Mining and Land Company, Ltd., show a net profit of £25,604 for the year ended June 30 last, increasing the balance brought in to £70,545. After making sundry allowances, there remained a credit balance of £62,227. A dividend of 5% has been declared in respect of the current year.

Northern Rhodesia.—The accounts of Roan Antelope Copper Mines, Ltd., for the year ended June 30 last cover an operating period of 10 months, during which a

profit of £156,740 was realized, this figure being subject to debenture interest and depreciation. After allowing for these items there was a debit of £30,760 to be carried to the balance sheet. During the year 1,184,040 tons of ore was mined and sent to the mill, together with 205,200 tons from the stock-pile, the average tenor of the whole being 3·65% copper. At the smelter 45,298 tons of concentrates was treated, yielding 20,205 long tons of blister. The cost of production for the three months ended June 30 was £25·660 per ton, a figure which fell to £23·013 per ton in the quarter ended September 30 last, these figures being subject to charges for interest and depreciation.

The report of the Rhokana Corporation for the year to June 30 last shows that over the operating period extending from April 1 to June 30 a working profit of £25,721 was made. After making allowance for debenture interest and other items, there was a debit balance of £156,987 to be carried to the balance sheet. Up to June 30 last 15,812 tons of blister copper had been produced at an average cost of £25·92 per ton—a figure which does not allow for interest or depreciation charges. On the same basis 12,739 tons were produced in the three months of the current year ended September 30 last at a cost of £22·389.

During the 15 months to September 30 last the Rhodesian Selection Trust issued $6,612,000 in debentures in satisfaction of advances. Last July $3,207,000 in debentures was cancelled in exchange for 3,514,520 fully-paid 5s. shares, while a further $30,000 was cancelled by purchase. The company's interest in Mufulira Copper Mines, Ltd., has been valued at £3,000,000.

Shareholders of Rhodesia Broken Hill Development Co., Ltd., were informed last month that arrangements had been made to resume the production of electrolytic zinc on January 1 next. The whole of the estimated output of 18,500 tons for 1933 has, it is stated, been sold.

A progress report issued to shareholders of the Rhodesia-Katanga company last month confirmed the suspension of work at the Kansanshi mine pending an improvement in conditions. The company has, in conjunction with Tanganyika Concessions and the Zambesia Exploring Company, taken an option on the holdings of the Eldoret Mining Syndicate in the Kakamega goldfield, Kenya.

Nigeria.—The accounts of Jantar Nigeria for the year ended September 30 last show a profit of £3,752, increasing the credit balance brought in to £20,410, which is carried forward. The declared output for the year was 143 tons of tin concentrates, a figure which will be reduced during the current year to 118 tons under new quota arrangements.

Gold Coast.—The report of Ariston Gold Mines (1929), Ltd., for the year to September 30 last shows a profit of £60,930. After making various allowances there remains a credit balance of £23,222 to be carried forward. During the year 63,779 tons of ore was crushed, the gold produced realizing £172,888. The monthly tonnage dealt with rose from 5,745 in January last to 7,095 in October, the working profit in the same period rising from £6,220 per month to £13,360. The ore reserves at the end of the year were estimated at 230,000 tons, of an average assay value of 11·7 dwt., while it is estimated that the opening up of the 18th level next year will add a further 220,000 tons to the reserves. At the annual meeting to be held this month it will be proposed that the capital of the company be increased to £700,000 by the creation of 1,600,000 new shares of 2s. 6d. each. The company has entered into an agreement with Anfargah Gold Mines for the acquisition of their property, the purchase price of £100,000 to be satisfied by the allotment of 800,000 of the new shares, the balance of which are to be offered to existing shareholders at 2s. 6d. premium to provide capital for sinking a new shaft to open up and develop Anfargah and the south end of Prestea.

The report of the Gold Coast Selection Trust for the year ended March 31 last shows a debit balance of £257. The company, which owns an interest in Anfargah Gold Mines and the Ariston company, proposes to increase its capital from £70,000 to £500,000 and to consolidate the ordinary and deferred shares into one class, and resolutions having this end in view will be proposed at the annual meeting to be held this month.

Australia.—A new agreement has been concluded with the labour unions at Broken Hill providing for a wage of 14s. per day, with a system of bonuses depending on the price of lead, to come into force when lead reaches £16 per ton.

Shareholders of the Zinc Corporation have been informed that no interim distribution on the ordinary shares is to be made this year, consideration of a dividend being deferred until complete accounts for 1932 are available.

Initial results from Mount Coolon Gold Mines have been announced, the clean-up from the mill at the conclusion of the experimental running period, expiring October 31, yielding 1,136 oz. of gold. During the first ten days of November 1,600 tons of ore was treated for bullion containing 1,116 oz. of gold.

During the year to June 30 last Lake View and Star, Ltd., made a profit of £284,146, which, added to the balance brought in, gave an available total of £295,343. After making various allowances, there remained a credit balance of £131,526. As most of this sum had been utilized as capital and expended on plant, it was decided to place £100,000 to reserve and carry forward the balance of £31,526. During the year 299,080 tons of ore was treated for £614,209. The total ore reserves at June 30 last were estimated to be 1,832,437 tons, having an average value of 33·96s. per ton. Developments at the mine continue encouraging and the company recently declared a dividend of 12½% in respect of the current year.

The accounts of the Wiluna Gold Corporation, which owns the Wiluna Gold Mines, Ltd., show a total income of £3,428 during the year to March 31 last, while, after meeting all charges, there was a loss of £37,865, increasing the debit balance brought in to £61,547. Results obtained by the operating company show a great improvement as compared with the previous year, for during the period from January to October, 1932, 275,181 tons of ore was treated for gold worth £599,918, the working surplus for the period amounting to £277,231. The ore reserves at August 31 last totalled 1,257,000 tons, an increase of 478,000 tons over the figure at October 1, 1931. The average value of the reserves is given as 33s. 4d. per ton, while it is estimated that recovery can be increased to not less than 84% and costs should be reduced to 18s. per ton in Australian currency. It is estimated that the scale of operations will be increased to 40,000 tons monthly by the middle of 1933.

The petition of South Kalgurli Consolidated to reduce its capital from £150,000 to £112,500 by the return of 2s. 6d. on each 10s. share has been sanctioned by the Court.

The report of Star Explorations, Ltd., for the year ended September 30 last shows a profit of £5,466, increasing the balance brought in to £8,464. Of this amount £2,422 has been distributed as a dividend, equal to 10%, and £4,500 placed to reserve, leaving, after making other allowances, a balance of £1,542 to be carried forward.

New Zealand.—At a meeting of Progress Mines of New Zealand held last month it was proposed that the company should be voluntarily wound up.

Korea.—Shareholders of the Chosen Corporation, Ltd., have been informed that the East Nurupi mine is being reopened.

China.—The report of the Chinese Engineering and Mining Company for the year ended June 30 last shows a profit of £142,153, increasing the balance brought in to £146,041, of which £98,099 is absorbed by income tax. A sum of £2,500 is to be transferred from reserve and a dividend of 2½% declared, leaving a balance of £1,442 to be carried forward.

Panama.—A meeting of the debenture-holders of the Panama Corporation (Canada) is to be held in Montreal this month, when a plan postponing the payment of interest until June 1, 1935, will be submitted for approval. A preliminary meeting held in London earlier this month has called for certain modifications of the original scheme.

Venezuela.—The report of New Goldfields of Venezuela, Ltd., for the year ended June 30 last shows a loss of £50,511, increasing the debit balance brought in to £79,828. Conditions at the mine continue to improve, the tonnage treated by the mill having been gradually increased and operating costs reduced, the figures for August last showing an operating profit of Bs. 3·46 per ton. During the year under review 81,085 tons of ore was milled for 24,425 oz. of gold. The ore reserves at June 30 last were estimated at 486,397 tons, averaging 8·6 dwt.

Portugal.—A circular to shareholders of Beralt Tin and Wolfram states that, in order to provide funds for the repayment of loans on the Barking factory and the purchase of tin concentrates, it has been arranged to allot fully-paid shares of the company without any commission.

Cornwall.—At a meeting of Geevor Tin Mines to be held this month proposals are to be submitted for a reorganization of the capital, so as to get rid of the debit balance on profit and loss account.

Mining Trust.—The accounts of the Mining Trust for the year to June 30 last show a balance of income over expenditure of £65,458. This sum, carried to appropriation account, has helped to write off the value of shares and advances to the Société des Mines de St. Sebastien d'Aigrefeuille and to reduce the value of the Villemagne holding.

THE TUAPEKA CONGLOMERATES

By G. W. THOMSON, M.I.M.M.

A description of the cemented gravel deposits in the Tuapeka district of Otago, New Zealand.

In the issue of the MAGAZINE for October, 1931, there was a short reference to the "huge cemented gravel deposits in the Tuapeka district of Otago" and the author feels that some detailed information concerning these enormous auriferous gravel areas might be of interest. Geologists who have examined them are still at variance in their theories as to the actual mode of deposition. They are gravel deposits certainly, but whether they are partly glacial and partly river, or purely river gravels is still debated. The majority of opinion is probably toward the latter opinion.

of a current, such as, for example, may be seen on the shingle beaches of any stream. The pebbles point in all directions, but the majority are lying flat. It is perhaps possible that this may be due to slight decomposition and disintegration of the gravel, followed by a settlement of the mass, over the long periods during which it reached its great depth of at least 500 ft. The general appearance now is very like a concrete, the ingredients of which are a thorough mixture of rounded gravel, sand, and cement. It is this similarity to a concrete that was the origin of the name given it by the early miners of "cement,"

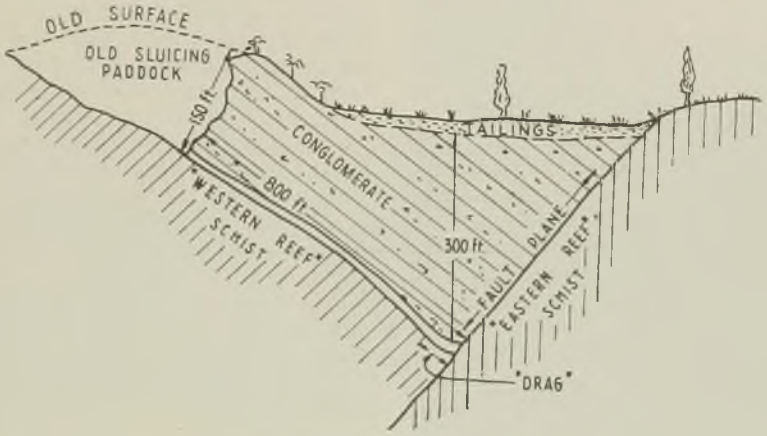


FIG. 1.—DIAGRAMMATIC SECTION ACROSS THE TUAPEKA CONGLOMERATE AT THE GOLDEN CRESCENT TUNNEL.

Under the circumstances it is perhaps unsafe for a mere mining engineer to venture his opinion, but the author's observation leads him to think that the gravel was deposited in a very muddy condition (possibly as a slurry), as the pebbles are almost invariably surrounded by, or embedded in, a very much finer matrix of what appears to have been originally a schist mud and sand, and which was evidently present in considerable quantity, much more so, he considers, than could be expected in a river gravel. Further, although the conglomerate usually lies in a flattish V-shaped trough with an ill-defined stratification roughly paralleling the schist bottom of the western side, yet so far he has not been able to determine any common direction of lie of the gravel and boulders that would indicate the direction particularly as its colour when fresh and unoxidized is similar to the greyness of new concrete.

Leaving this question to the geologists to settle, there is, however, one geological feature on which there is now general agreement, viz., that the several places where this conglomerate is to be found lie along a fault plane which strikes roughly N.N.W. by S.S.E., with its dip to the west of about 35° (Fig. 1). The conglomerate deposits are found intermittently along this fault, from the famous Blue Spur deposit at the north followed by the Wetherstones, Forsyth, Waitahuna, Glenore, and Adams Flat areas to the south, a total distance of 12 to 15 miles.

The generally accepted view, the author believes, is that this auriferous gravel was

deposited prior to any fault movement, but he inclines to the view that probably the fault movement started before and was in progress during the deposition of the gravels, which may account for the depth of the deposit, this being, so far as definitely known, 500 ft. A further indication is to be seen in the fact that, in the inclined tunnel driven by the Golden Crescent Company at Wetherstones,

FIG. 2.—VIEW IN OLD SLUICING PADDOCK, SHOWING FACE OF CONGLOMERATE (C), 150 FT. HIGH, RESTING ON THE SCHIST FLOOR (S).

starting at the feather edge on the west side and following down the conglomerate-schist contact to the gutter where it meets the fault plane, there are distinctly better values the deeper it goes to 670 ft. From this point to 800 ft., however, the ground is very disturbed and consists of a mixture of fractured schist and conglomerate, the result, obviously, of a " drag " due to the vicinity of the fault plane. Unfortunately, it has not been possible to examine this last 130 ft., as there is extraneous water which has been allowed to enter from the surface. It is reported to the author, however, that the gold values as indicated by the pan, were low, but that a considerable quantity of secondary pyrites was present. This is of interest, as there are strong indications that this secondary pyrites carries gold values revealed only by fire assay, a matter which is dealt with more fully later in this article. Too little development work has been done to permit of a definite opinion, but the fact that the richest values are found near this gutter seems to indicate that this was in existence previous to, and probably continued during, the deposition of the gravel with its gold content.

Other movements have occurred, possibly in the nature of block faulting—the movement planes crossing the main fault line, because, although the line of these conglomerate areas is regular, they themselves are intermittent and it is generally thought that at the places where there is now no " cement " these sections were lifted up, and that, owing to its soft nature, the overlying conglomerate became disintegrated and so dispersed. With the exception of the Blue Spur section, it is obvious that the blocks of conglomerate, as now known, were moved down to below the erosion line, which has thus resulted in their preservation.

Economically these deposits are interesting on account of their gold content. Generally speaking gold is found throughout their entire depth, the best, of course, as is usual in gravels, lying on the bed-rock, but also up in the conglomerate for a short distance. These bottom values apparently lie in bands or leads and some of them have been rich enough for the miners of 60 years ago to mine profitably and then crush in the primitive stamp-batteries of their day. Increasing depth, however, as they followed down from the surface, eventually made it unprofitable by the crude hand appliances of that day and work ceased. It was not until about 1929 that the Golden Crescent Company showed its enterprise by putting down an exploratory incline that any further work along the western conglomerate-schist contact was done.

THE " CEMENT."—As has already been noticed, the deposits have every appearance of a newly-made concrete. At the surface, however, it has weathered to a red, or reddish-yellow, colour and has the consistency of a stiffish clay, but is soft enough to lend itself

readily to exploitation by hydraulic sluicing methods. At depths varying from a few feet to 30 ft. the unaltered grey conglomerate is reached. This is much harder and cannot be dealt with economically by the jet. It is, however, from a lode-miner's point of view, a soft rock. As an illustration, it may be said that it is a fairly easy matter with only an ordinary miner's pick to cut very even and clean-cut sample channels.

The pebbles consist chiefly of quartz, greywacke, jasperoid, schist, etc., and in size vary from ½ in. pebbles to about 8 in. in diameter. It is rare that anything larger is met. The siliceous pebbles remain hard and unaltered, but the schistose ones are decomposed and are now much softer than the enveloping matrix. This matrix appears to be a very intimate mixture of fine-grained material which appears to be derived from schist.

A noticeable feature of the deposit is the comparatively rapid disintegration that takes place when lumps of it are exposed to the atmosphere. Large lumps of up to 3 ft. in diameter, which have been left during sluicing operations as being much too hard to bother with, can readily be broken up with a light pick, in the course of from six to twelve months.

Gold Values.—Values occur all through the deposit, the best being undoubtedly on the schist floor or in the bottom 3 ft. of the conglomerate. No one, as yet, has any real idea as to the values in the upper layers, but they obviously exist, because the early miners, following down the "Western Reef" contact, only ceased sluicing when the conglomerate became too hard for the hydraulic jet to break.

The writer recently had an opportunity of sampling the bottom 3 ft. of this conglomerate as exposed in the Golden Crescent inclined drive previously mentioned. The samples were 3 ft. in height and extended up from a point 2 in. down in the underlying schist. The drive follows the conglomerate-schist contact, on the western side. This is locally known as the "Western Reef," a name handed down by the early alluvial miners. This "Western Reef" is undoubtedly the schist bottom upon which the deposit was originally laid down. To the east is the fault plane, known as the "Eastern Reef." This rarely has economic values, except at the surface where there have been found several rich patches, the result, probably, of surface reconcentration.

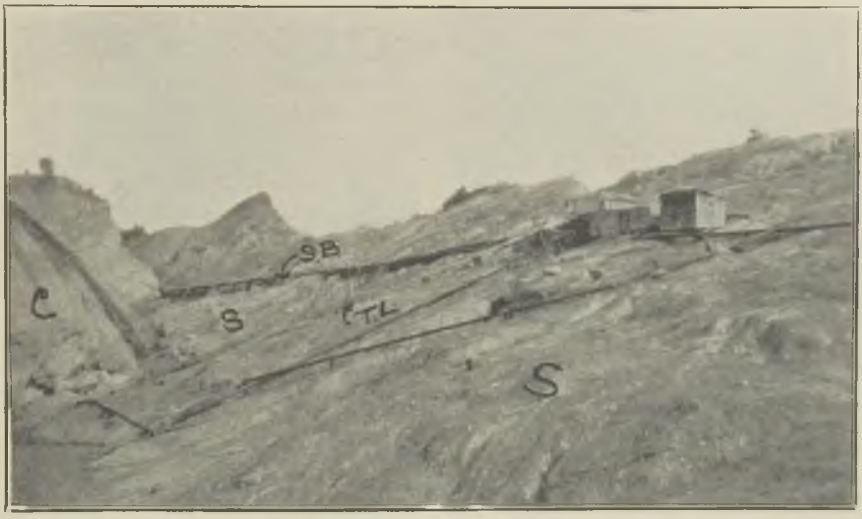


Fig. 3.—An Old Sluicing Paddock, showing conglomerate resting on the schist floor. The Tramline (T.L.) to the Golden Crescent Tunnel is shown, as are the sluice-boxes (S.B.).

Two methods of sampling were adopted, partly for checking purposes, and partly for the further information to be gained. They were as follows :—

(*a*) The usual mine-sampling method by the cutting of channels at a regular distance apart. In this case, the sample cut was at right angles to the schist bottom and extended up into the conglomerate for 3 ft. One to two inches of the schist bottom were

also included in order to make sure of any gold lying at the contact.

(*b*) The other method was undertaken more with the view of trying to get an idea of the value per unit of area of the bottom. A hitch was first cut in the conglomerate, some 8 in. from the bottom, the area of which was roughly a square foot. This was then dressed down so as to leave a thickness of 6 in. A rectangular block was then cut down to and included 1 in. of the schist bottom. The space was carefully dressed as smoothly and rectangularly as possible, and exact measurements made, particular care being taken to measure the floor area exposed. The average area of these samples was 8 in. by 9 in.

The samples were weighed, and thus a factor for tons compared to yardage was obtained of 1 cu. yd. = 1·93 tons or, say, 1 yard = 2 tons. In both cases the samples were dealt with as follows :—

Dried, weighed, and dollied down to $\frac{1}{4}$ in. They were then panned to a concentrate (pyrite and visible gold) of one to two ounces in weight, which was dried and then sent to the assayer with directions to get the entire gold out of the sample sent him. The gold was weighed and the value per ton or yard was calculated back to the original weight of the sample. A somewhat crude method, perhaps, but it was considered that as such it would more truly represent what might be expected in actual practice.

The results obtained were :—

(*a*) 15·94 grains per sq. ft. = 5·9 dwt. per sq. yd.

(*b*) 12·75 grains per sq. ft. = 4·78 dwt. per sq. yd.,

which, considering the nature of the material samples, are reasonably close checks, especially when it is remembered that (*a*) is for a height from bottom of 36 in., whereas (*b*) is for 6 in. only.

These results were then considered in the light of actual recovery from the tunnel and an average figure taken of 12·5 grains per square foot, or 4·7 dwt. per square yard of floor by one yard high. This average is based on the samples over the entire length of 670 ft. sampled. The first 300 ft., however, only averaged 5s. and was too poor to be considered. Assuming that this low-grade area could be eliminated by selective mining, the tenor of the balance of about 55% could be expected to average 7·43 dwt. per square yard of bottom by one yard high.

This, therefore, might be considered as giving an indication of the possible value of roughly half the floor area of the conglomerate in this neighbourhood, but which, of course, requires further development work in order to confirm the probable wider distribution.

Prospecting.—A local syndicate is now busy on a prospecting scheme, driving along the gold leads exposed in the tunnel. A small and very simple mill is also being erected, which will crush the spoil from this development work and then run it through sluice-boxes. It is the syndicate's intention to treat about 2,000 cu. yd., the result of which will be looked for with great interest.

Hitherto the method has been to dump the uncrushed conglomerate direct from the mine into a large sluice-box. Large lumps of conglomerate were thus rushed through the box unbroken and would undoubtedly carry off any of their mechanically-held gold contents. The amount of water used was also such as to preclude the possibility of any of the fine gold being caught, which, by careful panning of the dump, is now known to be present.

Pyrites.—Traces of secondary pyrites exist throughout the entire conglomerate. The bottom 10 to 15 ft., however, contains probably up to 2% by weight. Careful panning and amalgamation tests, to eliminate all free gold, indicate that there is probably not less than 1 oz. per ton in this pyrites. This is a recent rediscovery. The late S. Herbert Cox, in 1879, reported 11 oz. per ton and a recent sample sent to the Dominion Laboratory assayed over 30 oz. Since the beginning of the field, however, there has been no attempt made whatsoever to try and save this mineral and the tonnage of this valuable product, which has been allowed to run to waste since 1865, must be very large.

Preliminary small flotation tests show that this pyrites is easily floated and the syndicate previously mentioned is shortly adding a small flotation set to confirm the laboratory experiments. It is of interest to note that many of the larger flakes of gold in the clean-up are found to be covered more or less completely with iron pyrites, very firmly attached. This may explain why this secondary pyrites is auriferous, the original solution of which seized upon fine particles of gold as nuclei for deposition.

Mining.—Mining of the bottom layer, whether 3 ft. in height or up to 15 ft., will be

easy. A combination of 28-lb. jack-hammer with 23-lb. pneumatic pick is being tried out. The results so far are favourable and it is probable that a scheme of a lightly-loaded hole or two merely to shake the ground will prepare it for very easy picking down by these pneumatic picks and it is hoped that, by working a wide face of 8 to 12 ft. in width, this light blasting, followed by picking, can be kept going almost continuously.

MILLING.—This will be of the simplest, all that is necessary being to wash the disintegrated "cement" through sluices in order to catch the coarse gold, which is present in flakes up to 1 to 2 dwt. in weight. The conglomerate breaks up very small when blasted and broken down by the pick, about 40% to 50% being less than $\frac{1}{4}$-in. size. The larger pieces up to 8 in. to 10 in. in diameter are so soft that when dropped from 3 to 4 ft. on to firm ground they are instantly shattered. So easily is it broken that tests now being made indicate that successful results will be obtained by dropping the ore with water down a series of 40° steel-lined chutes, set at right angles, the last one to be a $\frac{1}{2}$-in. grizzly, which will deliver an oversize of the unbroken hard quartz and jasperoid pebbles to waste with an undersize to go direct to the sluices.

The further flow-sheet depends on the flotation tests now being carried out, but it is probable that the tailings from the sluice-boxes will be de-watered and fed into a large size ball-mill to crush to, very approximately, 60 mesh. Flotation reagents will be added, and instead of steel balls, the oversize quartz and jasperoid boulders from the $\frac{1}{2}$-in. grizzly will be sorted and the most suitable will be taken out and used in the ball-mill. The pulp from this mill will then be dealt with in one or other of the various flotation cells most suited for the work.

The grade of the "ore" is low and as simple a method of treatment as possible is necessary, with an eye only to the highest economic recovery rather than a technical one. It is almost certain, from the tests so far completed, that something along the above lines will eventually be evolved and in a way what simpler method could be designed than one where the ore to be treated will crush itself, the only wear being in the liners of the mill? Even this will be much less than usual, due to the extreme softness and non-abrasive character of the pulp.

BIBLIOGRAPHY.—Many articles, papers, etc., on the deposit have been printed during the last 60 years. Probably the best and certainly the latest is that by Dr. Marshall, and published by the New Zealand Government Geological Survey under the title "The Geology of the Tuapeka District." Dr. Marshall's review was made in 1912. To give some idea of the hugeness of these deposits, he there estimates that in this one area, known as "Wetherstones" that there is at least 413,000,000 cu. yd. Since then, however, a large amount of sluicing has been done, as well as this Golden Crescent Tunnel driven down the contact and, in the light of recent observation, the author has no hesitation in saying that that figure is very conservative.

The writer's acknowledgements are due to Messrs. Industries, Ltd., for permission to publish the above sample values.

FIG. 4.—VIEW LOOKING DOWN THE TUNNEL OF THE GOLDEN CRESCENT SLUICING CO., SHOWING THE CONGLOMERATE (C) RESTING ON THE SCHIST FLOOR (S). At this point the dip of the contact is 9°.

LIGHTNING.—II

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

In this, the second of a series of four articles, the author discusses the formation of a storm and the separation of electricity.

In general terms some of the features of lightning were described in the last article, where some dimensions were given in order that readers might have more exact information than that usually provided. The present article proceeds to a detailed description of the way in which a lightning storm is formed and of how the separation of electricity is carried out.

The initial energy is provided by the sun's radiation, which evaporates water from the sea and from damp and forest areas. The warm air is more capable than cold air of holding water and as it rises it expands and the moisture becomes visible as cloud. These clouds form and develop in a characteristic way and their rounded masses are known as cumulus clouds, from which, as they develop, columns of hot, moist air arise to form the towering clouds (cumulo-nimbus) which are so characteristic of tropical seas or tropical valleys. These clouds may be seen forming at the sea's surface in Fig. 7*a*. Ten minutes thereafter the warm moist air rises in columns (Fig. 7*b*) and another ten minutes sees the cloud rapidly expanding (Fig. 7*c*). The transfer of energy in such a cloud formation is on an immense scale. For instance, a cumulo-nimbus cloud, about 3 miles diameter and rising 3 miles, might easily be lifting 200,000 tons of water, and if it took an hour, the h.p. used in that lift alone would be about 180,000. The rising warm air movement thus started by the action of the sun on the sea needs an incoming cooler air movement to balance it, and this is the initial cause of wind.

It is not necessary to go more closely into this topic than to mention that the transfer of moisture by winds and air currents can very easily be accounted for. Whenever a wind strikes an obstacle, such as a bare hillside or a forest, or a sea, or another wind, or a cold wind, its direction is changed and a certain amount of turbulence is caused. If the turbulence is great a vortex will probably be formed, which might act as the starting point of a thunderstorm. It is very noticeable that plateaux and isolated hills are usually associated with thunderstorms; the wind blowing against the plateau edge will cause an upward vortex, while the heat playing on a bare rocky hill projecting from a plain will cause a similar effect. Opposing winds have the same effect and, in fact, should there be a relative motion of any one body of air past or through another, by whatever means it is caused, a more or less stormy atmosphere will result.

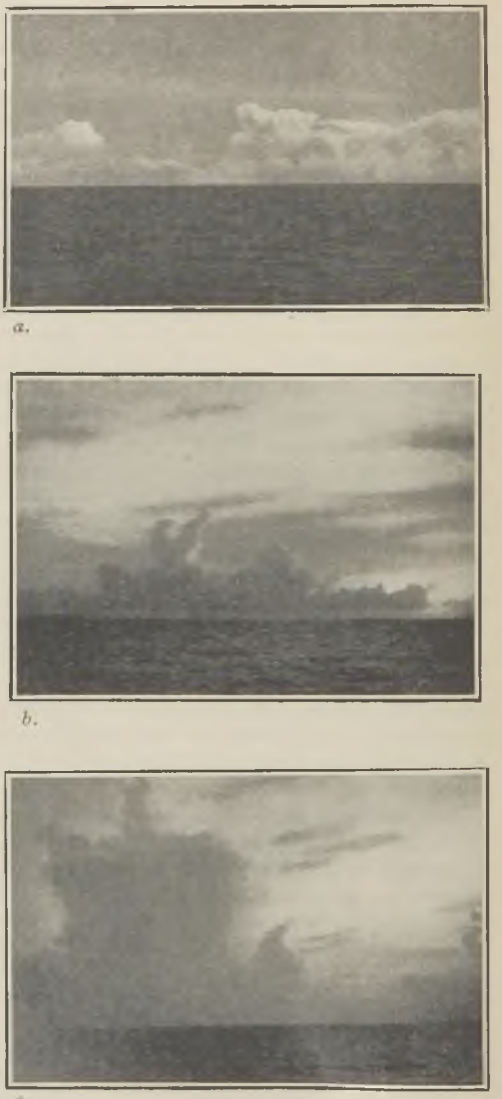


FIG. 7.—STAGES IN THE FORMATION OF A STORM. (*a*) Clouds forming at the sea's surface. (*b*) Moist air rising in columns. (*c*) Clouds rapidly expanding.

Incidentally, the association of a thunderstorm with a vortex was noticed over 3,000 years ago, and is mentioned in the play called "The Clouds" by the Greek writer Aristophanes.

A typical thunderstorm is shown in section in Fig. 8. The storm cloud may be about 3 to 7 miles in diameter, and its bottom about 600 ft. from the ground, while its full height may extend to 18,000 ft. or even higher. The cloud itself is bright when illuminated by the sun, but there is darkness within and underneath the cloud because of the intense concentration of moisture, which shuts out all light. The bottom of the cloud usually has dark, threatening edges, which are clearly shown in Figs. 10 and 11 and in the cross section in Fig. 8. They are the result of the vortex action. The vortex is fed by a wind of warm moist air, which may attain a speed of 100 miles per hour as it feeds into the rising column. The wind is horizontal when the storm is low down.

What goes on inside the vortex has been revealed by two writers: An aeronaut named Professor John Wise has left us a most vivid description of a 20 minute stay inside a storm cloud that he could not avoid. His balloon was forcibly raised and dropped a great distance many times in succession inside the cloud. During the whole time the balloon was being rapidly revolved and subjected to the most violent turbulent action in which rain, snow, and hail seemed to have been bombarding him from every angle. The noise was terrific.

Within the last few weeks another description has been published by von Buttlar, who was in charge of a Zeppelin which was returning from a raid on England during the war. He encountered a head wind of about 50 miles per hour when he was flying at a height of 10,000 ft., and he found he had no alternative but to fly the airship through a storm which was several miles long and 18,000 ft. high. The ship flew into the storm at 3,600 ft., and within a few moments experienced a regular cloudburst of rain. The whole ship then shook with a violent vertical squall, dropping 2,000 ft. suddenly, and then suddenly rising to 6,000 ft. Meanwhile, flashes of lightning were growing ever more violent and more frequent, and the whole ship was lit up at one moment and swallowed up in the darkness the next. The crew then found themselves speeding through violet light and again in darkness. They found electric discharges were taking place from every direction, such as the sides of the machine gun and the sailors' caps. They were flying through a violet cloud and they themselves were discharging electricity. Shocks were obtained from pieces of metal, such as compasses lying on the chart, and during the whole period, which was apparently two hours, the vertical squalls were extremely violent. The ship was repeatedly driven up and down between 6,000 and 600 ft. altitude.

In the first article it was stated that the amount of energy in one lightning flash was about 3,000 k.w. hours. If during a storm lasting two hours there can be almost incessant lightning, there must be a great deal of energy available. It has already been mentioned that even a small storm, 3 miles diameter, on rising only a small height, may contain a great deal of energy, while a large storm, or series of storms, would have enormous resources at its disposal. In fact, in the lightning storm we have a condensing steam turbine of colossal size. The heat or energy conveying medium is the warm, moist air, which is really steam mixed with air. The turbine casing is the surrounding atmosphere, while the condenser is the high, cold region of the atmosphere. As the column of moist air rises into the colder heights the steam condenses and its stored energy is thus liberated. It is this energy that is available for separating the electricity, the actual separation being due to the breaking up of drops of water. It is well known that when drops of water are forcibly broken up into smaller drops, the latter become electrified. But when drops of water fall down through the air they cannot fall faster than a certain speed, depending upon the size of drop. It is possible for the smaller drops to unite to form larger and heavier ones, but there is a precise limit to the size of drop, and this size of drop has a definite speed of fall. These limits are roughly $\frac{1}{4}$ in. diameter for the drop and 18 miles per hr. for the speed of fall. If the latter speed is exceeded the drop will be split up and each of its resulting smaller drops will be electrified. In a thunderstorm the rain falls from the upper portion of the cloud, where the cold has condensed the vapour, but some of this rain meets the vortex of rising air, which is, as we have seen, an exceedingly strong upward wind. This not only arrests the falling rain, but carries it upward again,

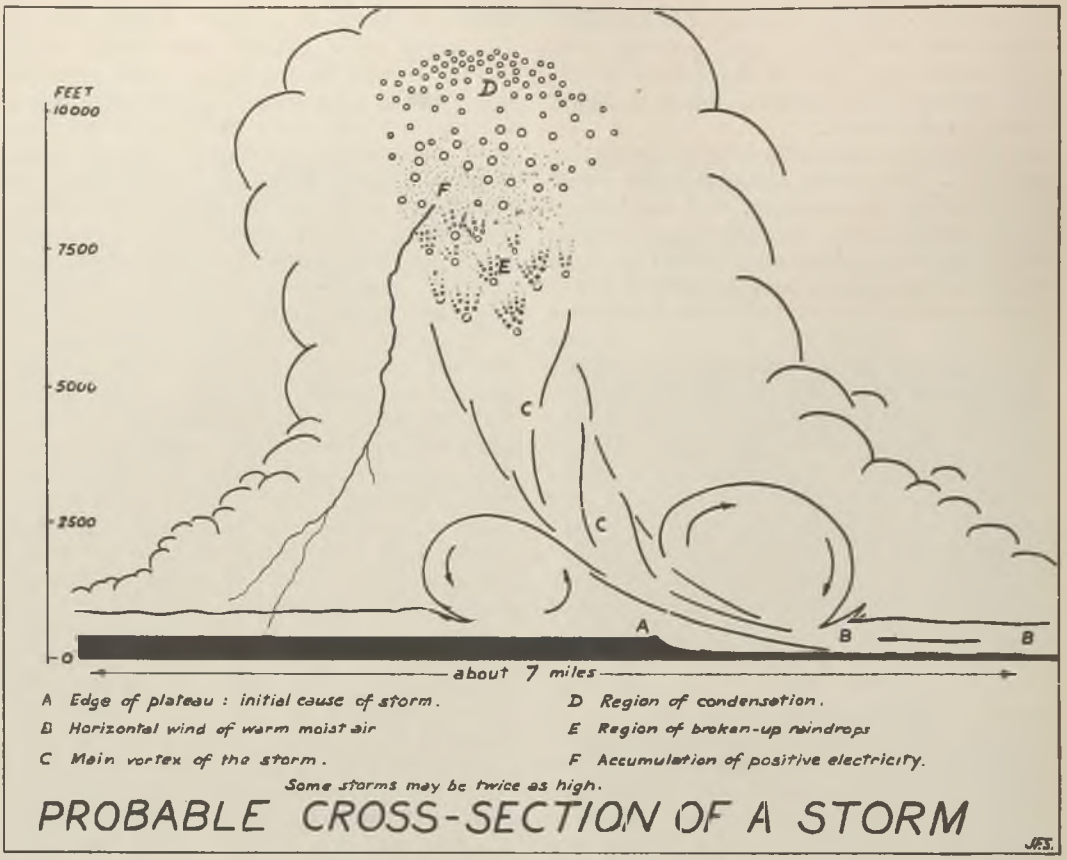


FIG. 8.

with the result that the raindrops are broken up and electrified. As they are carried up they eventually reach a region where the wind does not overcome the force of gravity, when they unite because they are electrified, and down the drops fall again, only to meet the vortex lower down and be shattered. It can be understood that this action is rapidly progressive, so that the region near the top of the vortex becomes a dense mass of raindrops in violent agitation, exactly as described by Professor Wise. When the vortex current slows up and eventually ceases, the whole of this dense mass of water falls as intense rain on a very localized area. This is especially the case in the tropics, where the storms are larger, and the amount of moisture, and therefore of energy, is greater than in more temperate regions. The author has frequently seen sharp-edged chasms of about 150 ft. diameter and 50 ft. deep cut out of a hillside by such a cloudburst.

To return to the storm centre : Each time a drop is shattered its droplets become positively electrified, while the corresponding negative charge is carried off by the air. This process is cumulative and very soon the electrical difference of potential between the two separated portions of electricity becomes very intense. When the stress between the positive and negative portions thus separated reaches about 75,000 volts an inch a small portion of the intervening air becomes so hot that it becomes a small conductor and gets hotter still owing to the current flowing in it. This conducting stream further concentrates the already intense electric stress and as a result the small spot of hot air rapidly extends.

It must be understood that there is always an electrical stress in the air, even on a quiet day, and that this is concentrated by any electrical current flowing in it. A force is produced by the interaction of the current and the electric field, so that a small

FIG. 9.—JU-JU ROCK, JEBBA, NIGERIA.

current concentrates the field and enables a larger current to flow, which process goes on increasingly rapidly, so that the conductor of white-hot air, starting from a spot, rapidly extends into regions far beyond the originally electrified region from which it started. In fact, once the air is stressed to the breakdown limit, the process just described takes place in a few millionths of a second. The initial heating of the air does not necessarily occur at the beginning or the end of the flash, but it will occur at the most intensely stressed portion of the field, which appears to us to be a chance spot, whence it is propagated as atmospheric conditions permit. This is borne out by pictures taken with high-speed moving cameras. The tips of the path of the stream may be imagined as having a very pushing action, which, in their endeavours to reach out in all directions renders the channel liable to branch. There comes, of course, a place at the end of each branch where the forces balance and the flash ends. If the separation of electricity continues inside the thunderstorm, and the hot path is still (even partly) in existence, it is likely that there will be further discharges down the same channel, time after time, with the variations that might be expected from the stressed air and the disturbed conditions.

The mass of positive electricity is held by raindrops, but the negative portion is held by the molecules of air and these negative discharges of electricity gradually become distributed throughout the cloud mass by the turbulent conditions which have already been described. This negative electrification may, therefore, reach such an intensity that a breakdown may occur to earth, but, as the area throughout which it is distributed is very extensive, the flash usually takes a characteristic shape, and usually its upper branches are forked towards the cloud, as shown in Figs. 6*b* and 6*c*.

In tropical regions the thunder clouds rise to very great heights and in the late afternoon and early evening accumulations of electricity may be seen discharging to each other in the tops of the clouds. The

FIG. 10.—STORM GATHERING OVER THE JU-JU ROCK, JEBBA, NIGERIA.

author has watched such discharges for long periods, and Fig. 5 is a photograph of them. The magnificent cumulo-nimbus cloud does not show in this picture owing to the late hour at which the photograph was taken. The discharge is probably from the high-up positive portion of the cloud, where the drops are being broken up, to the negative portion around it. The height is estimated at about 16,000 ft. Such high clouds do not discharge to earth because the sparking distance is too great, and the upward current and rainfall appears to be carried on right up at the top of the cloud without any external signs of the usual horizontal wind. The discharges are not intense, and are silent, but they occur every few minutes for periods of 3 or 4 hours during evenings from about 5 to 9 p.m.

The actions described above may be summed up in a general way by the drawing in Fig. 8, which is based upon Dr. Simpson's diagrams.

Electrification by splitting up drops is well known to engineers used to hydraulic mining, where it is possible, on occasion, to get a very strong shock from the nozzle of a monitor.

The author is also acquainted with a hydro-electric power-station in the Sill Valley, near Innsbruck, where there is a pipe-line with a head of about 670 ft. The pipe-line has to be drained occasionally, and the surplus energy of the water in it distributed, this being done in what the engineer calls a "horse-power cemetery." It consists merely of a concrete pit of about 10 ft. cube, filled with a stack of old rails against which the water under full head is released. When this occurs the column of water breaks up into millions of drops and violent electrical discharges are to be seen there, under and over the surface of the foaming water, while a terrific noise, exactly like thunder, is produced.

Many mining engineers will also recollect cases where wet steam blown off from a safety valve or a whistle has produced sufficient electrification to cause a severe shock to the operator through whom the discharge was made. These facts were well-known in the seventies, for in London, at the Polytechnic, an insulated steam boiler was arranged with a large number of jets from which, when wet steam was blown off, electricity was collected. The spark was 22 in. long, which would correspond to about 45,000 volts. The effect was noticeable only when the steam was wet, i.e. when drops were formed and split up by the energy of the steam. Friction does not appear to be the source of the separation of electricity, although it does appear to have an effect when dust is blown violently through the air, as was mentioned in the first of these articles.

Fig. 11.—Storm over the Bauchi Plateau, Nigeria.

The author believes that the geology of the soil has practically nothing to do with the incidence of a lightning flash. Others have stated that a flash will be "drawn towards" a metallic lode, or to a body of ore, or even to the boundary plane of two kinds of rock. A lightning storm is a meteorological phenomenon, and depends upon the wind to a large degree.

The large scale physical contour of a country has a great influence on the wind, and therefore considerable influence on the storm. A bare hill on a flat plain, or the edge of a plateau can often become the starting point of a thunderstorm, as Figs. 9, 10, and 11 show. Figs. 9 and 10 are photographs of the Ju-Ju Rock at Jebba in Nigeria, while Fig. 11 shows a characteristic lightning storm of the Bauchi Plateau. It was formed by the plateau edge turning up the incoming wind and so initiating the storm. The storm was then guided up to the valley head, where it dispersed itself.

The spot where a vortex will form cannot with certainty be predicted, but the author's observations on the spot convince him that, where the conditions just described occur, then thunderstorms will assuredly happen. Many observers forget that a storm has very variable dimensions, which are of the order of 3 to 10 miles across, and up to 4 or 5 miles high, and that the position in such a storm of the intensely electrified region is a very variable one, in no way influenced by the composition of the terrain.

THE MEASUREMENT OF AIR-COMPRESSOR EFFICIENCIES

By H. G. SMITH, B.Sc.

(*Concluded from the November issue, p.* 287)

A simple method of determining the compression efficiency is to measure by means of a planimeter, or other means, the respective areas of the isothermal diagram and the actual diagram obtained. Then :—

$$N_c = \frac{\text{Area of isothermal diagram}}{\text{Area of indicator diagram}}$$

The isothermal diagram relative to the cylinder volumes, V_1 and V_2, corresponding to the initial and final pressures, P_1 and P_2, can easily be constructed. The value of the compression efficiency can also be determined by calculation, provided the index of compression n is known. This index can be determined from examination of the compression curve obtained from the actual indicator cards. Several indicator diagrams are taken so as to get a true average value.

The Determination of the Index of Compression n.—Fig. 5 represents a typical indicator card, on which AB is the suction pressure line and EF the absolute pressure line. Any two points a and b are selected on the compression curve and perpendiculars dropped to m and n on the absolute pressure line. The equation of the compression curve is $PV^n = C$, but, as the volume is proportional to the length of the cylinder, $Pl^n = C$, $P = am$ and bn, and $l = om$ and no ; or $\log P + n \log l = \log C = K$. Values of P and l are taken from several indicator cards at various points on the smooth parts of the compression curves. The logs of these values are next found and the values of $\log P$ are plotted against those of $\log l$. A straight line as shown in Fig. 6 is obtained.

The value of n is obtained from the slope of the line :—

i.e., $$\frac{ac}{cb} = n.$$

Let P_1 = the initial or suction pressure in lb. per sq. in., P_2 = the final or delivery pressure in lb. per sq. in., V_1 = the initial volume in cu. ft., and n = the compression index which in practice varies between 1·25 and 1·3. Then it can be shown that for isothermal compression work done on the air

$$= 144 P_1 V_1 \log_e P_2/P_1 \text{ ft.-lb.}$$
$$= 331 \cdot 2 P_1 V_1 \log_{10} P_2/P_1 \text{ ft.-lb.}$$

With a single-stage compressor the actual

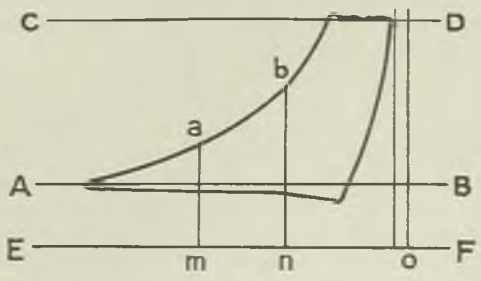


Fig. 5.

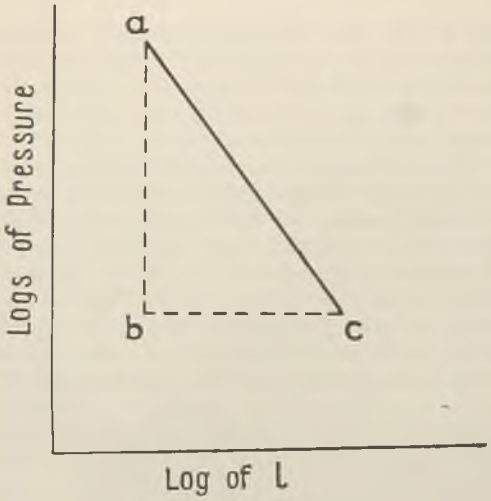


FIG. 6.

work done on the air

$$= \frac{n}{n-1}\left[P_1V_1\left\{\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right\}\right] 144 \text{ ft.-lb.}$$

With a two-stage compressor the actual work done on the air

$$= \frac{2n}{n-1}\left[P_1V_1\left\{\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{2n}} - 1\right\}\right] 144 \text{ ft.-lb.}$$

Thus for two-stage compression the compression efficiency

$$= \frac{331 \cdot 2P_1V_1 \log \frac{P_2}{P_1}}{\frac{2n}{n-1}\left[P_1V_1\left\{\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{2n}} - 1\right\}\right] 144.}$$

The efficiency of compression is of no very great importance to the mine manager. It is a criterion of the efficiency of the cooling system, but the condition of this system can be judged from the value of the index of compression obtained from the indicator card. The value of n in moderate practice lies between 1·25 and 1·3. Values of n below 1·25 should be treated with suspicion as they generally indicate leaky pistons or suction valves.

3.—MECHANICAL EFFICIENCY.—This is usually defined as the ratio of the air-indicator horse-power to the brake horse-power supplied to the compressor.

The air indicated horse-power is, of course, the product of the mean effective pressure obtained from the air-indicator diagram and the piston displacement. The brake horse-power supplied to the compressor is very difficult and almost impossible to determine at the mine. The manufacturer has, however, designed an apparatus for determining the b.h.p. supplied to the compressor shaft,[1] but this method is only applicable in the laboratory. In the case of electric motors the manufacturer often supplies a curve showing the relationship between the b.h.p. and the r.p.m. of the motor. Hence, if the compressor is driven by such a motor, a value for the mechanical efficiency can be estimated.

4.—OVERALL EFFICIENCY.—The overall efficiency is generally defined as the ratio of power available in the delivered air, to the indicated horse-power of the prime mover.

The power available in the delivered air represents isothermal conditions. All heat energy that may be in the air when it leaves the compressor is lost before the air is used, and hence, no matter how the air is compressed, the useful work done can only be that which would have been accomplished had the air been compressed isothermally. Hence the overall efficiency

$$= \frac{331 \cdot 2P_1V_1 \log P_2/P_1}{33{,}000 \quad \text{i.h.p. of prime mover.}}$$

In the case of a steam-driven compressor the i.h.p. of the prime mover is given by the i.h.p. of the steam cylinders, and in the case of an electrically-driven compressor, either the reading of a wattmeter or the product of the voltmeter and ammeter readings. The simplest and most effective way of measuring this important efficiency is to have on the output side of the compressor an air-meter and on the input side a steam flow-meter in the case of a steam engine, or wattmeter in the case of a motor. Thus a rigid and practically continuous check can be kept on the overall efficiency.

Heat Balance Sheets.—It is a useful plan to draw up heat balance sheets in order to show how the heat produced by compression is expended. The heat balance sheets of successive tests will show at a glance any improvements or defects in the cooling system. The measurements required are the temperatures at the inlets and outlets of the water circulated through the cylinder jackets and intercoolers, the suction and delivery temperatures and pressures, and the b.h.p. supplied. As the b.h.p. cannot often be determined the air h.p. is used along with a factor. The readings and data given in Table III were obtained in an efficiency test on a two-stage single-acting Reavell compressor.

[1] Ford, J. M., "The Compressor Theory and Practice." Constable, 1923.

TABLE III

R.p.m. of compressor	400
Diameter of H.P. cylinder, in.	6
,, L.P. ,, ,,	9
Length of stroke, in.	7
Average delivery pressure, i.e. receiver pressure (lb. per sq. in.)	53
,, receiver temperature, ° F.	75
,, delivery temperature between air compressor and receiver, ° F.	197
Pressure of the air at suction, lb. per sq. in. abs.	14·7
Temperature of the air at suction, ° F.	60
Mean Effective pressure from the indicator cards in lb. per sq. in. abs. — H.P. cylinder	32
Mean Effective pressure from the indicator cards in lb. per sq. in. abs. — L.P. ,,	15·1
Average Volts of motor	225
,, Amps ,,	58
The motor efficiency at 400 revs.	0·85
Volumetric efficiency of the compressor at 400 revs. determined in the example given under the Orifice Method	0·89
Weight of water circulated through the jackets given in pounds of water per minute	11·5
Weight of water circulated through the intercooler (lb. per min.)	11·1
Inlet temperature of water circulated through the jackets, ° F.	41
Outlet temperature of water circulated through the jackets, ° F.	58
Inlet temperature of water circulated through the intercooler, ° F.	41
Outlet temperature of water circulated through the intercooler, ° F.	54·5

The following calculations were possible on these data :—

1.—*Efficiency of Compression.*—

a.—The h.p. required for isothermal compression

$$= \frac{331 \cdot 2\ P_1 V_1 \log \frac{P_2}{P_1}}{33{,}000} = 9 \cdot 0.$$

b.—The i.h.p. represented by the H.P. cylinder indicator diagram

$$= \frac{P.L.A.N.}{33{,}000} = 6 \cdot 4.$$

c.—The i.h.p. represented by the L.P. cylinder indicator diagram = 6·8.

Efficiency of Compression

$$= \frac{\text{Work done on air under isothermal compression}}{\text{Work done on air under actual conditions}}$$

$$= 68 \cdot 2\%.$$

2.—*The Overall Efficiency of the Compressor Plant.*—

a.—e.h.p. of the prime mover

$$= \frac{\text{Amps.} \times \text{Volts}}{746} = 17 \cdot 4.$$

b.—b.h.p. supplied to compressor. From the chart supplied by the manufacturer, the efficiency of the compressor at 400 revs. is 0·85,

$$\therefore \text{ b.h.p. of motor} = 17 \cdot 4 \times 0 \cdot 85 = 14 \cdot 8.$$

Mechanical Efficiency of Air-Compressor

$$= \frac{\text{Air-indicated horse-power}}{\text{b.h.p. supplied to compressor}} = 89 \cdot 2\%.$$

Overall Efficiency of the Compressor Plant

$$= \frac{\text{Power available in the delivered air}}{\text{e.h.p. of motor}} = 51 \cdot 8\%.$$

3.—*Heat Balance Sheet for the Compressor.*—

a.—Heat expended in the air cylinders

$$= \frac{33{,}000 \times \text{b.h.p. supplied to compressor}}{778}$$

$$= 628 \text{ B.Th.U.s.}$$

b.—Heat taken up by the water circulating through the jackets = wt. of water circulated per min. × rise in temp. of water = 195·5 B.Th.U.s.

c.—Heat taken up by the water circulating through the intercooler = wt. of water circulated per min. through the intercooler × the rise in temp. of the water = 149·5 B.Th.U.s.

d.—Heat rejected in the air. If the compression had been isothermal the temperature of the delivered air would have been 60° F. and not 197° F. Hence the heat rejected in the air = the heat which would raise the temperature of the weight of air at delivery pressure from the suction to the delivery temperature.

The weight of delivered air $= \frac{PV}{RT}$, from equation 1, = 6·95 lb. per minute.

Heat rejected in the air = weight of air delivered per min. × (delivery temp. − the suction temp.) × specific heat of air = 226 B.Th.U.s.

A heat balance sheet is shown in Table IV.

RELATIVE IMPORTANCE OF THE VARIOUS EFFICIENCIES.—The mine manager is chiefly concerned with the cost of the production of his compressed air. He desires to know the volume of air which can be compressed to a certain gauge pressure and the cost of this compression. The greater the volume com-

TABLE IV

HEAT BALANCE SHEET

Heat energy given to the air.	*B.Th.U.s per min.*	%
Heat derived from work done on air	628	100

Heat energy accounted for.	*B.Th.U.s per min.*	%
Heat absorbed by cylinder water jackets	195·5	31
Heat absorbed by intercooler	149·5	24
Heat rejected in delivered air	226	36
Heat unaccounted for (radiation, etc.)	57	9
	628	100

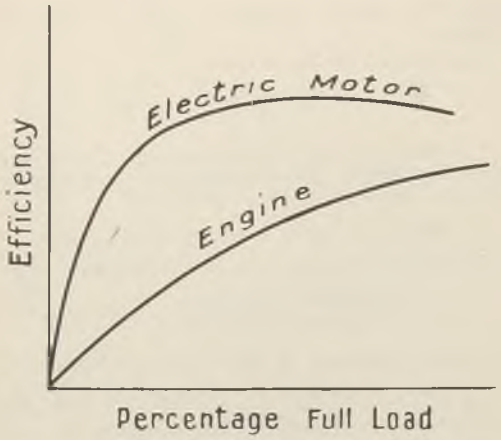


Fig. 7.

pressed and the lower the cost of compression, the more efficient is his compressed-air plant. Hence the most important efficiency from the point of view of the mine manager is the overall efficiency, because this indirectly indicates the cost of production of compressed air, the higher being its value the lower the operating costs of the plant. For the direct-coupled electrically-driven high-speed air-compressor a reasonably expected figure for the overall efficiency would be 60–65%, whereas with steam-driven installations this figure is a little lower.

In the old days, when compressors were bought on the volume-swept-out basis, the volumetric efficiency was very important. Nowadays compressors are usually bought on a guarantee to compress a certain volume of free air to a definite pressure, without expending more than a set number of energy units. High delivery efficiencies do not necessarily indicate high overall efficiencies, but to obtain a good overall efficiency the various subsidiary efficiencies should be reasonably high.

The efficiency of compression is of no great value to the mine manager, although to the engineer it is very important. It is a criterion of the efficiency of the cooling system, although this can to some extent be determined from the value of n obtained from the indicator cards.

The overall efficiency is often objected to on the ground that it saddles the compressor with the inefficiency of the prime mover. The mechanical efficiency, where the b.h.p. is substituted for the i.h.p. of the prime mover, gives an efficiency which is much fairer to the compressor. As already indicated the b.h.p. supplied to the compressor is difficult to measure.

Summing up, it may be said that the only satisfactory criterion of the performance of a compressing plant is its overall efficiency. This efficiency includes all the other partial efficiencies and the manager need worry little about the volumetric, compression, or mechanical efficiencies so long as the overall efficiency is satisfactory. However, in the case of a plant upon which a test is being run, it is necessary for the engineer to determine the separate efficiencies, in order that he can ascertain to what particular the compressor is deficient.

Effect of Load Factor on the Efficiency of a Compressed-Air Plant.—The efficiency of a compressed-air plant is intimately bound up with the load factor. Rock-drills, haulage engines, hoists, etc., cause violent fluctuations in the demand for compressed-air power at a mine. This, of course, means that the load factor is continually changing and hence the efficiency of the plant is affected. If the "load-factor efficiency" curve of an electric motor be examined it will be found that the modern electric motor gives a relatively high efficiency over a large range of loading. In this respect it is far superior to gas, steam, or oil engines. Fig. 7 shows the shape of such "load-factor-efficiency" curves for the electric motor and the steam engine. Thus, judging solely on the viewpoint of higher efficiencies on greatly varying loads, electric motors are preferable to steam, oil, or gas engines as the prime movers of compressors.

Fig. 8 is a curve showing the relative cost

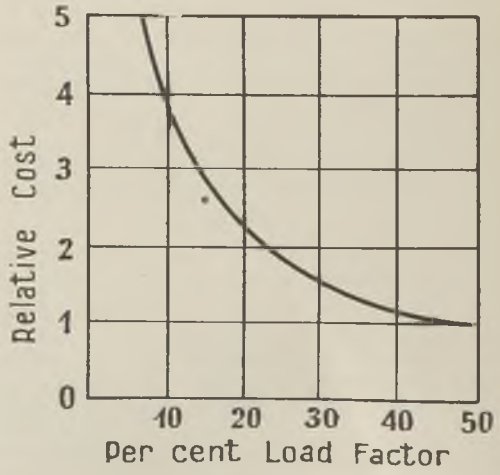


Fig. 8.

of production including fuel, labour, interest, and depreciation, for load factors varying from 10 to 50%. It will be noticed that if the load factor is low then the cost of production becomes excessive.

Effect on Stage Pressures of Valve on Piston Leakage.—Probably the most delicate part of a compressor is the valves and it is here that trouble is most likely to arise. It is, of course, impossible to examine the action of the valves whilst the compressor is running, but sometimes by noting the behaviour of the compressor, without even taking indicator cards, it is possible to locate faults in its action.

In a multi-stage machine pressure gauges are arranged to read each stage pressure. The deviation of any of these gauges from the value they normally indicate is practically a certain indication of leakage in either the piston packing or of one or more valves. Valve leakage in a cylinder of a given stage generally results in an increase of pressure in the preceding stage or stages, whilst the pressures in the succeeding stages remain normal or are slightly reduced, due to extra leakage as a result of the augmented pressures in the lower stages, or as a result of the reduction of the volumetric efficiency of the first stage.

A leaky valve in the higher stages of compression does not affect the output of the compressor to any great extent, except in so far as the increase in the first stage pressure has the effect of reducing the volumetric efficiency of the compressor. Should the L.P. cylinder valves be defective the weight of air drawn into the cylinder is affected with a result that the succeeding stage pressures are lower than normal. Thus it can be said that, in general, it is possible to locate the cylinder in which the trouble lies by noting the deviation of the stage pressures from their normal values, but to decide whether it is the suction or delivery valves that are at fault the plant must of necessity be closed down.

For example, the case of a three-stage compressor may be taken. It is noted that the reading of the L.P. stage is higher than normal, whilst the I.P. stage pressure gauge registers its usual value. This indicates a faulty valve or valves in the I.P. cylinder. Suppose the compressor is now shut down and, as it stops, the L.P. stage pressure gauge is seen to rise slightly, then one can be fairly certain that the trouble lies in the I.P. cylinder suction valves. If on stopping the compressor the gauge remains stationary the trouble may still possibly lie in the I.P. cylinder suction valves, but it is most likely to be found in the delivery valves of that cylinder.

To test further for a leaky suction valve the L.P. intercooler should be blown down a little and, as the cock is closed, the L.P. gauge should be watched closely. If the I.P. cylinder suction valves are faulty, air will leak through from the I.P. cylinder to the intercooler, thus causing the L.P. stage pressure gauge to rise slightly. Should the gauge remain stationary the delivery valve is probably at fault.

The above methods are unfortunately not infallible, as abnormal stage pressure gauge readings may be due to various causes such as leaky pistons, or variations in the temperature of some portions of the cycle, due to inefficiency in the cooling system.

The design of the compressor determines the effect of piston leakage on the stage pressures. In some designs, air leaking past a piston, merely passes to a lower stage in the compression, whilst in other designs of compressor it passes into the atmosphere. In the latter case leakage past the pistons will obviously cause a fall in the higher stage pressures, due to the fact that these stages will be dealing with less than the normal amount of air, whilst the lower stages will remain unaltered.

A variation in the revolutions per minute of an air-compressor may cause fluctuations in the various stage pressures, due to a change in the velocity of the air passing through valves and coolers.

Compressor Indicator Cards.—Indicator cards are useful, apart from the fact that they indicate the work done in the cylinders, in that they give a complete record of the events taking place inside a cylinder during a cycle. It is necessary first of all to obtain indicator cards from the various cylinders of the compressor when the latter has just been overhauled and is working efficiently. These should be carefully labelled and preserved for future reference. It is advisable that cards should be taken at frequent intervals, say every week-end. By comparing them with the ones taken when all was in order much can be learned as to the state of the valves, pistons, the efficiency of cooling, etc.

Fig. 4 shows a typical indicator diagram for a single-stage compressor in good condition. Here it will be noticed that :—

1.—On the suction stroke the cylinder

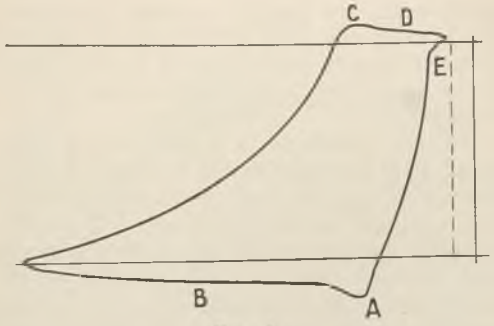


Fig. 9.

pressure falls below atmospheric before the suction valve opens. After this takes place the suction pressure approximates to, if not actually coinciding with, the atmospheric pressure. At the end of the stroke the suction and atmospheric pressures are identical.

2.—The compression curve should be between the isothermal and adiabatic lines, but nearer to the latter than the former.

3.—The delivery pressure line is generally wavy, the amplitude of waves falling off towards the end of the stroke. This is due to the fact that when the delivery valve opens there is a surge towards the receiver, which is followed by a backward surge from the receiver, and so on.

Fig. 9 is an indicator card showing several common defects. The following points will be noticed :—

1.—The dip on the diagram at *A* indicates that the resistance to the opening of the suction valves is very great, i.e. the valve springs are too tight.

2.—The fact that the suction line *B* is so far below the atmospheric line throughout the whole of the stroke, shows that there is throttling or wire drawing due to :—

(*a*) too long or too narrow a suction pipe ;

(*b*) too small an opening of the inlet valves.

3.—The hump at *C* again indicates the delivery valve springs are too tight.

4.—The height of *D* above the receiver pressure line indicates too narrow a delivery pipe, or that the area of delivery valve openings is too small. The area included in between the delivery line and the receiver pressure line is a measure of the energy wasted in overcoming the resistance to the delivered air.

5.—The kink at *E* indicates sluggish closing of the delivery valve, thus permitting the entry of pressure air to surge back into the cylinder at the commencement of the suction stroke.

Fig. 10 shows the effect of a leaky piston. It will be noted that the suction line crosses the atmospheric line and rises to a value *A*. This shows that, as the pressure of the air on the other side of the piston increases, some air is forced past the piston causing the pressure on the suction side of the piston to rise. This leakage of air will also cause a change in the compression curve. The latter curve will be found to approximate more closely to the isothermal line, implying, of course, a higher efficiency of compression than really is the case. It should be noted, however, that if there is excessive throttling the leakage of air past the piston might just compensate for this shortage of suction air, thus causing the point *A* to be on the atmospheric line as is normal, yet, at the same time, there is excessive piston leakage. It is always advisable, therefore, to plot the isothermal lines on diagrams taken from the compressor or to determine the index *n* from the cards.

Leaky suction valves may be the cause of the compression line approaching the isothermal. In this case, however, the clearance-volume-expansion line falls steeply, giving an apparently longer effective suction stroke than is actually the case. Thus in cases where the compression curve approaches closely to the isothermal the condition of the piston and the suction valves should be carefully examined. If, on the other hand, the compression curve approaches very close to the adiabatic line something is radically wrong with the cooling system (which fact can be determined by trying the temperature of the delivered air) or the discharge valves are leaking badly.

The obtaining of accurate indicator cards from an air-compressor is by no means a simple matter. The design of most compressors generally necessitates long connexions, which, in the case of small H.P. cylinders, adds appreciably to the clearance

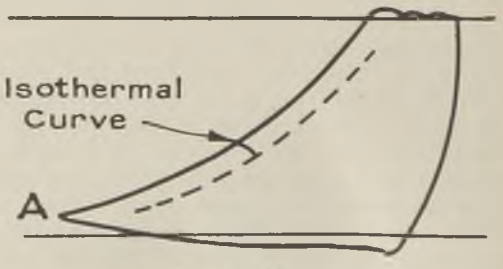


Fig. 10.

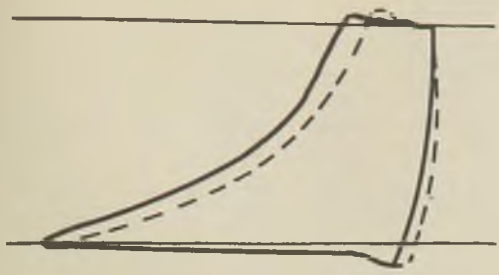


FIG. 11.—INDICATOR DIAGRAM, SHOWING THE EFFECT OF A LEAKY SUCTION VALVE.

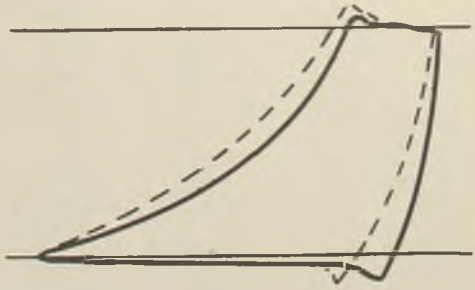


FIG. 12.—INDICATOR DIAGRAM, SHOWING THE EFFECT OF A LEAKY DELIVERY VALVE.

volume. With slow-speed compressors this difficulty may be overcome by filling the indicator, etc., with oil to take up the added clearance. At high speeds, however, the inertia of the oil introduces grave errors. Any reliable standard internal combustion type of indicator may be used for compressor work, but extreme care must be exercised in adjusting and manipulating the instrument to obtain accurate results. Among the common sources of error in using such an indicator are :—(1) Faulty connexions, i.e. leaks, etc., (2) inertia of the indicator, (3) faulty spring setting and scales, (4) faults in the reducing motion, and (5) ordinary indicator springs are often too stiff for the accurate recording of the suction line and it is preferable to take the suction line separately with a weak spring of say 5 lb. to the inch.

For speeds greater than 400 revs. the ordinary indicator is of little value. The "Micro-indicator" invented by W. G. Collins, of the Cambridge Instrument Company, is recommended for these high speeds.

NOVEL PRACTICE IN WATER CONCENTRATION

By S. H. HARMAN, A.I.M.M.

The author describes a method of recovering mineral values by water concentration in a stepped sluice-box coupled to a lanchut.

The labour, time, and mineral saving lay-out described in the following article, which is designed primarily for hillside hydraulic tin mining, is considered to register an advance on the simple sluice-box method of concentration. The cost is small, while retaining simplicity of manipulation and construction, where the lay-of-the-land permits installation. Neither the sluice-box, nor the lanchut as applied, present any marked novel features. The coupling of the sluice-box by a launder to a hopper, attached to the "dressing up" unit—the lanchut—for the end concentration process, being the only divergence from accepted practice. If required, a larger yardage treatment capacity than is possible in the single sluice-box shown in the plan is obtained by duplication of the sluice-box.

The lay-out described possesses the following advantages :—

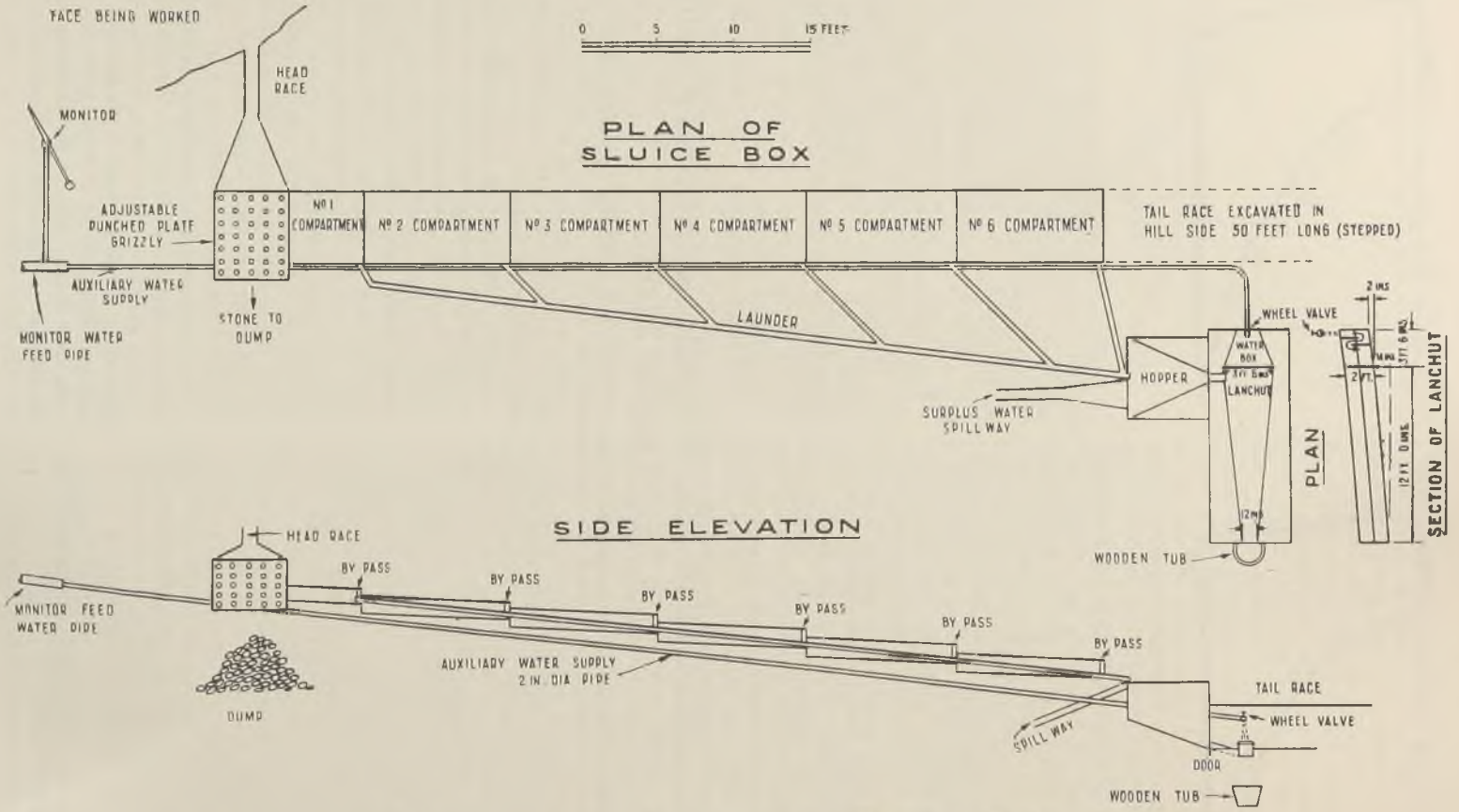
(1) The minimum of hand labour in the sluice-box, sufficient only to insure that the material does not pack.

(2) The time spent in the periodic clean-up in the simple sluice-box method is reduced to about one hour. Two men are required to flush out the sluice-box of the roughly concentrated material, which flows by gravity, to the hopper. On completing the flushing out of the sluice-box, the monitor operations recommence.

(3) The "dressing-up" of the rough concentrates in the lanchut allow a refinement not possible in the sluice-box, and effect a greater saving of "fines."

The following is a summary of the plant and its operation and it is illustrated by a diagrammatic plan and section, which furnishes details for construction and adequately describes the procedure :—

SLUICE-BOX.—This is divided into five or six stepped compartments, each 10 ft. long, by 4 ft. wide, with sides 1 or 2 ft. high. The



PLAN AND ELEVATION SHOWING COMBINED SLUICE-BOX-LANCHUT METHOD OF TIN CONCENTRATION.
In the elevation the grade represents 5%, the steps between the compartments showing a 6 in. drop.

From Sluice-Box Compartments	Proportion of total concentrate recoveries. Weight	Fineness—I.M.M. Screens (Dry Screening) No. 10 mesh oversize.	No. 12 mesh oversize.	No. 16 mesh oversize.	No. 20 mesh oversize.	No. 30 mesh oversize.	No. 60 mesh oversize.	No. 60 mesh undersize.	Total
	%	%	%	%	%	%	%	%	%
No. 1	49·00	41·7	12·5	11·1	12·5	2·8	16·6	2·8	100·00
No. 2	27·50	20·0	7·5	15·0	7·5	5·0	37·5	7·5	100·00
No. 3	12·25	16·6	11·1	12·5	11·1	5·5	27·7	15·5	100·00
No. 4	6·50	10·0	10·0	10·0	10·0	5·0	40·0	15·0	100·00
No. 5	4·75	7·14	7·14	7·14	7·14	7·14	50·0	14·3	100·00
Total	100·00	28·90	10·50	12·10	10·50	4·10	27·0	6·9	

The specific gravity of the concentrates (tin, wolfram) was 6·7–7·9.

The specific ,, ,, gangue (muscovite mica, quartz, felspar) was 2·5–2·85.

The purity of the recovered concentrates, on analysis, was 71·8% metal. (WO_3, 37·5%. Sn, 34·3%.)

The concentrates No. 60 mesh undersize from compartments Nos. 4 and 5, on analysis, showed only 62·7% metal. (WO_3, 18·0%. Sn, 44·7%.)

steps between the compartments are 6 to 12 in. deep; they afford the agitation essential and assist in breaking the material when passing down the sluice-box. As concentration develops in the sluice-box, riffles are added at the tail end of each compartment. One man is capable of efficiently treating granitic material in a 50 ft. box, to which a tail-race 50 ft. long is added.

The grade of the sluice-box shown in the section illustrated is a 3 ft. drop in 60 ft., but, as will be understood, this grade is not suited to all types of gangue material.

By-Pass and Launder.—At the end of each compartment in the sluice-box a sliding door is constructed, through which the rough concentrates are passed down the launder to the hopper.

Hopper.—This is constructed with a shelving bottom for the easy discharge of the rough concentrates to the lanchut. On one side of the hopper a spillway for surplus water is necessary. The rough concentrates are drawn from the hopper to the lanchut as required.

Lanchut.—This is as commonly constructed for tin "dressing up," but it has a gate in the water compartment better to control the quantity desired.

Auxiliary Water Supply.—Provided that no other source of clean water is available for the lanchut operations, a 2 in. diam. pipe-line is suitably joined from the monitor line supply to the water compartment of the lanchut. The man employed in "dressing up" the rough concentrates regulates the quantity of water required by means of a wheel-valve. When drawing the lanchut water from the monitor pipe line it is necessary so to construct the water compartment of the lanchut as to obtain a quiet flow.

Clean-Up Procedure.—The monitor water is played on some point where the amount of solids flowing to the sluice-box is reduced to the minimum. The rough concentrates from the first compartment are then flushed through to the hopper, ready for the final dressing-up in the lanchut, to which it is fed by gravity. Compartments Nos. 2–5 are similarly treated.

An alternative procedure would be first to "stream down" the sluice-box until the rough concentrates are reduced sufficiently in bulk as to be discharged from all compartments to the hopper in one flushing operation.

The "dressed" concentrate of tin and wolfram, on which the experiments were conducted, in a five-compartment sluice-box, gave the fairly representative percentage recovery figures for 176 hours monitor operations that are shown in the accompanying table.

On panning the tail-race, a low percentage of No. 10 mesh oversize concentrates was found and this points to the advisability of adding another 10 ft. compartment to the sluice-box, bringing the total length to 60 ft., as shown in the accompanying plan.

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.
E. T. McCarthy	25	0	0
Ashanti Goldfields Corporation, Ltd.	10	10	0
Central Mining and Investment Corp., Ltd.	10	10	0
Champion Reef Gold Mining Co., Ltd.	10	10	0
Gold Fields Rhodesian Development Co., Ltd.	10	10	0
Mountain Copper Co., Ltd.	10	10	0
Mysore Gold Mining Co., Ltd.	10	10	0
New Consolidated Goldfields, Ltd.	10	10	0
Ooregum Gold Mining Co. of India, Ltd.	10	10	0
Renong Tin Dredging Co., Ltd.	10	10	0
Robinson Deep, Ltd.	10	10	0
Simmer and Jack Mines, Ltd.	10	10	0
Sub Nigel, Ltd.	10	10	0
J. C. Allan	5	5	0
Diggers' Club	5	5	0
W. H. Rundall	5	5	0
F. Merricks	5	0	0
C. E. Blackett	2	2	0
J. E. Snelus	2	2	0
C. W. B. Jeppe	1	7	0
E. R. Bawden (additional)	1	1	0
H. Jones	1	1	0
C. T. Blackwell		10	0
Previously acknowledged	985	6	9
Total	£1,165	4	9

LETTERS TO THE EDITOR

" Modified Flotation Circuits "

SIR,—I have read Mr. R. R. Knuckey's article with extreme interest. Ball-mill efficiencies have been increased in recent years by using high circulating loads in the grinding circuit. This means that the pulp passes through the ball-mill quickly and over-grinding is prevented. In these circuits, when grinding complex lead-zinc sulphide ores, free galena particles are produced that are coarse enough, with their high specific gravity, to settle with the sands in classifiers of the rake type. These free galena particles are often sufficient in quantity to warrant concentration for their recovery at this point. If a satisfactory method of concentration is found, then the more free galena in coarser sizes that can be produced in this way the better. It becomes another point in favour of keeping as high a circulating load in the grinding circuit as possible.

The writer recently proposed a flow-sheet somewhat similar to that mentioned by Mr. Knuckey, but the problem of the flotation of the copper before the lead was involved. For a straight lead-zinc ore, where the reagents are added to the ball-mill feed, this free galena could be recovered by a unit flotation cell placed between the ball-mill and the classifier. The time required for the pulp to pass through the unit cell would be short, but sufficient for the recovery of the high-grade galena. In this way there would only be a small loss in head between the ball-mill discharge and the classifier, whereas in the flow-sheet described by Mr. Knuckey there is the area covered by tables, and the necessity of pumping the sands to a sufficient height to provide for sizing and distribution to tables.

ELDRED A. KNAPP.

London,
November 22.

SIR,—I have read with close attention the short but significant article contributed to your November issue by Mr. R. R. Knuckey and believe that the soundness of his views can be supported by theory and exemplified from practice. His suggestion of placing a sizer (i.e., a hindered-settling classifier delivering a series of products) in the primary classifier sands-return circuit is to be commended, not only for the reason he gives—viz., that it removes the fines from the oversize product and so prevents over-grinding — but also because of the improved concentration possible when the feed to tables is prepared by hindered-settling classification. The author's flow-sheet is, of course, particularly applicable where the whole of the concentration is done by gravity, as is usual with a tin ore. In such a case his " Slime to flotation " would read " Slime to tinyard," while " Coarse " might be tailings and/or middlings from a first set of tables, since the discharge from the coarse spigot or spigots of the sizer would probably contain free tin which, in accordance with the adage quoted in the article, should be taken at once. In supporting Mr. Knuckey's suggestion, I am speaking in favour of his flow-sheet and not advocating the use of any particular make of machine.

FRANK YEATES.

London,
November 22.

BOOK REVIEWS

Textbook of Mineralogy. By E. S. Dana. Fourth edition, revised by W. E. Ford. Cloth, octavo, 851 pages, illustrated. Price 34s. London: Chapman and Hall.

The first edition of Dana's "Textbook" appeared in 1877 and the second in 1898, while the third was published in 1922, the time interval between each edition being thus about 20 years. Now, however, after a lapse of only 10 years, a fourth edition has become necessary, in view of the advances in mineralogical science that have been made during the last decade. The new edition, like the third, has been revised by W. E. Ford and retains its familiar format, although there have been valuable additions to the contents, the most notable being a concise exposition of the X-ray methods of structural investigation and a new section on the origin, mode of occurrence, and associations of minerals. In addition, the descriptive section has been overhauled, about 220 new species being included, so that the work may be said to retain its character as an essential volume in the library of the mining geologist.

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, $10; afterwards, $12·50. New York and London: McGraw-Hill Publishing Co.

This series of books—intended to form a useful nucleus for the young mining engineer's library—has been published by the McGraw-Hill Company for the Seeley W. Mudd Fund of the American Institute of Mining and Metallurgical Engineers. Of the first of the series—that on "Technical Writing"—little need be said here, as this work of T. A. Rickard's is sufficiently well-known to need no further introduction. The second volume is a compendium covering the choice of methods in mining and metallurgy, the contributors' experiences being set out in such a manner as will illustrate the way in which choice has determined the method of handling the various problems described. In "A History of American Mining"—the third volume of the series—T. A. Rickard sketches the development of mining and metallurgy in the United States and describes the part which this has played in the growth of a nation in a manner which makes for easy and interesting reading. The fourth volume is a revision by Russell C. Fleming of the late C. Godfrey Gunther's book on "The Examination of Prospects," its inclusion providing for an adequate presentment of the practical side of economic geology. The final book—that dealing with "Mineral Economics"—has been edited by F. G. Tryon and E. C. Eckel and consists of lectures by well-known authorities under the auspices of the Brookings Institution of Washington intended to show the bearing of economics on the problems of mining engineering and geology. The foregoing briefly describes the scope of this small library, which can be said with justice fully to serve the purpose for which it is intended—a help to the young man starting his career or a guide to his elder brother.

☞ 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

JOHANNESBURG

November 3.

Far West Rand Extension.—Results of investigations carried out by engineers and geologists of the New Consolidated Gold Fields, Ltd., indicate that the sub-outcrop of the Witwatersrand Main Reef Series extends from Randfontein Estates through the farm Middelvlei No. 6 and the properties of the Western Areas, Ltd. (formerly owned by the Western Rand Estates, Ltd.) and for a further 30 miles westward to the Mooi River near Potchefstroom. The geological part of the preliminary prospecting operations was conducted by Dr. R. Krahmann, a visitor from Germany, who has specialized in the magnetic methods of investigation of ore deposits, and Dr. L. Reinecke, of Johannesburg. Although no actual exposures of Main Reef have been obtained, the sub-outcrop lying below the dolomite "blanket" has been closely defined, and the next step will be the sinking of a number of bore-holes to test the value of the reef in the new area, which

is equal in extent to two-thirds of the producing field lying between Randfontein and Springs. The Western Areas block of farms alone covers about 67 square miles. Bore-holes put down by the Western Rand Estates over 25 years ago on the Western Areas block struck reef at depths of between 2,000 and 3,000 ft. and core assays indicated very encouraging values. The New Consolidated Gold Fields has purchased the Western Areas block for £225,000. It has also secured options on a belt of farms extending from the Western Areas to Potchefstroom and is forming a company to carry out the drilling programme. Several Rand mining finance houses are participating in this enterprise. The new company will have an initial capital of £500,000 and will take over the Western Areas block and the options over the farms lying between that property and Potchefstroom.

Aerial Surveying.—The results of the recent aerial photographic survey of the Rooiberg Minerals Development Company's property, carried out by the Aircraft Operating Company, have been announced. The photographs, as interpreted by the Aircraft Operating Company's expert, revealed a number of "features" and subsequent examination of the ground by this expert resulted in his locating indications of ancient workings hitherto unnoticed by the Rooiberg Company's prospectors. These "features" and indications of ancient workings are being explored by means of excavations and bore-holes. Up to the present, while they have been the means of locating dykes and geological disturbances hitherto unsuspected, owing to the heavy overburden of sand, it is too early to say whether the work will yield any practical result in the discovery of payable ore-bodies. The programme of exploration which is now in operation consists of putting down, by means of shot drills, a number of shallow holes, thoroughly to test certain areas of the property where there would appear to be the best reason to hope for the discovery of further ore-bodies.

Bushveld Complex.—In his memoir, entitled "The Bushveld Igneous Complex of the Central Transvaal," just published by the South African Department of Mines and Industries, Dr. A. L. Hall, formerly Assistant Director of Geological Survey, describes the great mass of igneous rocks that is the dominating feature in the structure of the Province as a vast treasure ground that for many years to come will provide the mineralogist, the petrographer, and the geologist with a rich field to dig over. "Unfortunately," he says, "gold, the solitary non-competitive mineral commodity, has not so far proved a feature in the potential wealth of the Bushveld, but the dense cloud of international depression now resting heavily on the realization of all competitive wealth should not be allowed to obscure the fact that the Bushveld contains important resources of proved economic value that may with confidence be expected to come into their own again, as soon as the present world conditions of industrial stagnation shall have passed into history." The only occurrence of gold within the Bushveld that was worked for a time lies on the farm Waaikraal No. 205. It forms, as far as Dr. Hall is aware, the only recorded instance of that metal having been met with in the Complex. Other mineral deposits associated with the Complex are: Platinum, silver, tin, lead, zinc, vanadium, chromium, iron, tungsten, molybdenum, bismuth, arsenic, cobalt, nickel, asbestos, fluorspar, monazite, barytes, soda, and stone, including marble. The Complex covers a combined area of some 12,700 square miles in the shape of an elongated oval falling into the Transvaal along a major axis of about 288 miles.

Deep Mining Difficulties.—In the course of a paper read before the South African Institution of Engineers entitled "A Review of the Difficulties of Air Conditioning in Deep Mines and Suggested Economical Methods for Improvement" Dr. J. T. McIntyre said that in the light of present knowledge of the situation it was felt that a mining depth of about 8,300 ft. below Rand datum was just possible with existing wet stoping conditions, but that risks of heat stroke could only be prevented by the free use of the available compressed air, which was an expensive method of ventilation and could not be carried too far. Thus, practical economics would determine for any particular mine the depth at which the existing system ceased to show a profit in working. With drier methods of mining, however, and an efficient circulation of relatively dry inlet air there were possibilities of extending the horizon to at least 11,300 ft. below datum, provided the present geothermic gradient was maintained. One of the problems mentioned in the paper is the very large change in air pressure from

Rand-level to about 6,000 ft. below sea-level. If mines are driven to such depths, Dr. McIntyre suggested, then it appears that the men working in the low levels may require to live underground at sea-level probably for periods extending from a week to a month. Living quarters could be perfectly air-conditioned under these circumstances and the men would not be subjected to great extremes of temperature. The difficulties require very careful study from many points of view, but it is felt that the mining engineers on the Rand have ever been a progressive group and, when changes in method are suggested and can be proved beneficial, there is no doubt that they will tackle the job in an expeditious manner.

Oil in the Orange Free State.—In connexion with the reported discovery of oil near Harrismith, O.F.S., Mr. H. H. Humphreys of Bethlehem, O.F.S., states that as far back as 1908 it was known that some of the dykes and sheets in the Harrismith district were richly impregnated with oil in their cracks and crevices. This also occurs in the Bethlehem and other districts.

Rhodesian Tin.—The fact that the Government Metallurgist and the District Government Mining Engineer have inspected the Rungwe-Bikita tinfields in Victoria, Southern Rhodesia, recently is regarded locally as evincing a revival of interest in the fields. The tin deposits hereabouts are the only known tinfields in the colony, except for claims that have been spasmodically worked from time to time in the vicinity of Salisbury, and many experienced people cling to the belief that Victoria has a definite future as a tin-producing area. On the other hand, one would like to have the money which has been uselessly spent in the exploitation of these deposits, and probably this is a factor which the Government will have in mind when considering the application which has been made by the local people for official assistance in testing their potentialities. That tin occurs has been amply demonstrated, but successful mining is another proposition.

BRISBANE

October 25.

Mount Isa.—Official reports for September show that at the Mount Isa mine development work is being pushed ahead with the usual vigour in the Black Star section. The Davidson shaft on this lode has been placed in commission and preparations for making two stope winzes have begun. The mine is now working with a normal output of 2,000 tons of ore daily. On September 23 No. 3 furnace was blown in and, according to the report of the district inspector of mines, appears to be doing good work. At the mill there was last month being installed three May jigs, one of which is practically ready for use, while the other two were expected to be operating within a month. In the Rio Grande section diamond drilling underground has been continued. The G22 vertical hole has been completed at 175 ft. after satisfactorily proving the ore-bodies below this section. The drilling plant has now been removed to G38 cross-cut to determine the H40 ore-bodies at depth.

Coke for Mount Isa.—Since the Mount Isa company began production 15 months ago, the coke required for smelting has been obtained from New South Wales and overseas, as it was not procurable in Queensland. In order to meet this requisite, however, as well as to supply North Queensland generally, the erection of coke ovens by the State Government at the port of Bowen, some 750 miles by rail from Mount Isa, was begun about the middle of June last and is making good progress. It is expected that the ovens will be finished by the end of this year and that coke making will begin about February next. The layout provided for a battery of 45 ovens, at an estimated cost of £50,000. Railway siding accommodation has been arranged so that an additional 15 ovens can be added when needed. The coal for the manufacture of the coke will come from the State mine at Collinsville, Bowen coalfield, 52 miles by rail from Bowen. For Mount Isa use a coke of not less than 45% porosity is required, while the percentage of the coke produced from the Bowen field coal is approximately 65.

Mount Morgan.—Following the completion of arrangements with the Commonwealth Government for financial assistance, work on a comprehensive scale is now being carried on at Mount Morgan, Central Queensland. The rehabilitation of the plant was begun early in July and the "quarry" or 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 in March, 1931. The power house has been put in order and is ready for use. The

concentration plant at Mount Morgan is being renovated and 12 of the flotation cells are being redesigned. About 100 men were being employed last month. Research work in the laboratory has been intensively pursued and a small continuous unit for the treatment of 50 lb. of ore an hour has been installed and is now in operation. From this plant results have been obtained which will greatly help in fixing the conditions for running the large plant that is now ready for use. When results on a large scale become equal to those now being obtained on the half-ton unit, work is to proceed immediately to ensure the treatment of 150,000 tons of ore annually from the millions of tons still in the mine.

New Queensland Goldfield.—Amongst the several new discoveries of gold in Queensland, that at Cracow, in the Central district, is just now attracting most attention. Last month no less than nine new companies to operate on the field were registered in Brisbane and already a fair amount of development work is in progress, but not enough has been done to determine whether the good indication on the shallow ground will continue with depth. The deepest working so far is at 120 ft. As regards the field's future, the consensus of opinion of experienced miners there is that no limit can be set at this stage as to its possibilities and that it will take years of diamond drilling and development before an approximate estimate can be made of the extent of the auriferous body. At present, lack of water is hampering progress, but a start has been made to lay a line of pipes between the new township and permanent water, which is a considerable distance away. A customs crushing mill is to be erected, which will have a capacity of 250 tons a day. At the new, or revived, Lolworth gold diggings, in the Charters Towers district, a much-needed battery has been erected, but it is feared that there will be trouble as regards water for running it. There are some promising indications as a result of the work that has been done and one of the Government geologists has given it as his opinion that the next year's prospecting and development work, with a battery on the ground, should prove a critical test of this undeveloped field. Regarding Mount Wandoo, near Chillagoe, where Mr. A. Macdonald holds the principal mine, no report has yet been received of last month's work and probably there is not yet anything of importance to report. A company has lately been registered, called the Gold and Rare Metals, Ltd., with a nominal capital of £6,000 and with its registered office at Mount Wandoo.

Mount Coolon.—At Mount Coolon, Queensland, the British company, Mount Coolon Gold Mines, Ltd., is well advanced with the arrangement of shrinkage stoping both at the 100-ft. and 300-ft. levels. The reduction and cyanide plant is nearing completion and almost ready for a trial run.

Tin Mining.—The recent substantial rise in the price of tin has given a spirit to the mining of that metal in Queensland, especially in the Herberton district, the chief tin producer in the State. The returns of output for last month from this field are the most satisfactory for some time. Water just now is becoming somewhat restricted, but the alluvial workers will not have long to wait for thunderstorms to treat any stacked dirt. A certain amount of assistance is still being given to individual prospectors and is being granted in a form that promises better results than obtained under a former plan. The most important development reported in the past month from mines at Herberton is one that has occurred in the historical Great Northern tin mine, where the lode of late being worked, which hitherto has carried only blebs of tin, seems to be settling down into a well-defined seam with good values. Most of the previously-worked bodies of ore in this mine, which is over 50 years old, have been of considerable size and the latest development seems to indicate that another of the many successful runs of production experienced will once more reward the owners.

Australian Gold Bonus.—The bill introduced into the Federal Parliament about a month ago suspending the payment of the gold bonus has been passed. The payment ended on September 30 and is to be restored when the London mint price does not exceed £5 a fine ounce and the Melbourne mint price is not more than £5 10s. an ounce. The Prime Minister believes that this basis for the restoration of the bonus will be acceptable to the gold-mining industry.

Broken Hill Mining.—In his address to the annual meeting of Broken Hill South, Ltd., held in Melbourne the other day, the Chairman referred to the inadequate return from the mining operations of the company as the outstanding feature of the accounts. "As indicative of the adverse conditions under which the industry is labouring," said

Sir David, " it may be stated that during the past two years the accounts showed a loss of £55,051. However, if the lead on hand at the end of June last is realized under the conditions of the price and exchange ruling during the past three months, the loss will be converted into a slight profit, even at the current low prices." The company, it was added, had not been able to dispose of its full production of lead. The benefit accruing from the premiums on the exchange of metal sold in Great Britain was the chief factor which had enabled the mine to continue production. Without this assistance, Sir David said, the operations of the mine would almost certainly have been suspended.

Western Australian Gold.—A good deal of excitement has been caused in Western Australia over a new gold find at Wannaway, 12 miles south of Widgiemooltha, where a well-known prospector has uncovered a reef 4 ft. wide and running 2 oz. to the ton. There has been quite a rush to the place and many claims have been pegged out. The September output of the Golden Mile and Sons of Gwalia mines, at Leonora, with a number of smaller yields, was 38,000 oz. of gold, of the value, at the present price, of £300,000.

New Guinea.—In the account of the activities of the New Guinea Goldfields company, given in these columns last month, Mr. R. A. Archbold was represented as saying that the gold production from the alluvials at Golden Ridges would amount to 3,000 oz. per week. This should, of course, have read 3,000 oz. per month.

TORONTO

November 17.

Gold Production of Ontario.—The steady expansion of the gold mining industry of the province is shown by a report of the Ontario Department of Mines for the first nine months of the current year. Exclusive of gold recovered from nickel-copper mining and other miscellaneous sources and including a small value of silver, the output was $34,788,569, as compared with $31,415,336 for the corresponding months of last year—an increase of 10%. The Porcupine area with seven mines increased its ore milled by 7·9% and its value by 6·2%. Kirkland Lake camp, seven mines, showed gains of 6·8% in ore milled and 11·8% in value, while the corresponding figures for north-western Ontario were 84% and 85·4%. The Kirkland Lake area was again the largest producer, its lead over the Porcupine camp being 13·1% as against a 7·4% gain for the corresponding nine months of 1931. At the Porcupine the March mill ceased operations on July 31, while that of the Ankerite resumed work on May 1, leaving six mines active. At Kirkland Lake the list of producers was extended by Toburn, formerly Tough-Oakes-Burnside, which reopened its mill on August 4 and thus the list of active properties totalled seven at the end of the period. In North-Western Ontario the commencement of milling operations by the Moss mine on March 15 gave that area a total of four regularly-producing gold mines. Receipts of crude gold bullion from the Ontario gold mines for the nine months by the Royal Mint, Ottawa, had a total valuation of $34,819,773, without exchange. Exchange received by the mines totalled $4,425,570 for the period. The Dominion Bureau of Statistics reports that the Canadian gold production for the first nine months of the year reached a total of 2,271,842 oz., valued at $46,962,141, compared with 1,974,202 oz., worth $40,810,417, for the first nine months of 1931.

Sudbury.—International Nickel continues to regulate production in accordance with the demand for its output. Nickel and nickel products have recently been more in requisition and, although the improvement has been gradual, the business for October has shown a considerable increase. The Falconbridge has begun construction of a 200-ton concentrating mill and sintering plant, together with the necessary additions to the smelter for increasing the present treatment facilities by 50%. The schedule calls for the completion of the entire programme by April 1 next. Recent orders have been sufficiently large to tax both mine and plant to their capacity to keep pace with the expanding business and the directors are assured of a steady market to warrant the expenditure on construction. Gross operating profits for the quarter ending September amounted to $508,082, as compared with $167,423 for the previous quarter and $769,292 for the first nine months of the year. Prospecting has been actively carried on in the Swayze gold area resulting in many new discoveries, and showing that the mineralized zone extends over six townships. At the Kenty property high-grade samples have been taken out from a series of veins which have been opened out and traced for more than 7,000 ft.

Development will be pushed as soon as mining equipment can be brought in over the winter roads and two shafts will be sunk to open up the rich surface showings at depth. The Three Duck Syndicate has acquired a group of 25 claims in the Three Duck Lake section of the Swayze area, where high-grade surface values have been encountered. Diamond drilling equipment has been sent in.

Porcupine.—The output of bullion by the producing mines of this area during October was valued at $1,814,757 from 299,840 tons of ore, as compared with $1,857,892 from 282,127 tons during the previous month. Hollinger Consolidated has declared its regular dividend plus a bonus of 5 cents a share, this being the second bonus declared this year. This will involve a total disbursement for the year of $3,690,000 and indicates that practically all net earnings and exchange premiums are being returned to shareholders in the way of dividends. While Hollinger's net returns for the first half of the year might indicate that the earnings were not sufficient to cover the addition to dividends provided by bonus outlay it is understood, for the past three or four months, production has been on a larger scale than earlier in the year and the company will do something better than meet dividends plus bonus obligations. Dome Mines, Ltd., for the month of October produced bullion to the value of $308,513, as compared with $340,159 for September. Total production for the first ten months of the year was $3,384,472, as compared with $3,486,506 for the full year of 1931. During the third quarter the average recovery of gold at $7·32 per ton showed a slight decline, the net profits for that period amounting to $480,281. The McIntyre Porcupine will sink a winze from the 3,750-ft. level to 6,750 ft., opening up 19 new levels and making it the deepest mine in Canada. The new winze will be located about halfway between the two prominent discoveries made in the cross-cut to the south from the main or No. 11 shaft. One discovery which will be explored is a 64-ft. width of quartz located on the 3,750-ft. level in porphyry. Drilling to the 4,300-ft. level showed good ore indications.

Kirkland Lake.—During October the gold mines of the Kirkland Lake field treated 153,579 tons of ore producing bullion to the value of $1,972,676, as compared with the output in September of $1,943,008 from 151,253 tons. The Lake Shore mine for the three months ending September 30 reports bullion production of a value of $3,032,000, which compares with $3,327,026 for the previous quarter. The tonnage treated during the period was 204,645 tons, the grade of ore being $14·82, as compared with $16·31 for the previous quarter. Increase in bullion output is due to the treatment of higher grade, the average for the first nine months of last year being $12·77, as compared with the average of $15·30 for this year. The mill of the Wright-Hargreaves is operating at a rate of between 815 to 825 tons of ore a day, during October the value of the output being approximately $350,000. The annual report of the Teck-Hughes for the fiscal year ending August 31 showed a bullion recovery of $5,953,687, as compared with $5,973,120 for the preceding year. Operating profits were $3,723,291, as compared with $3,311,591. Ore reserves are estimated at 626,489 tons, valued at $7,931,338, or an average of $12·66 per ton, as compared with the average of $14·23 per ton during the previous year. Sylvanite Gold Mines is making good progress in opening up its new ore sections on the 2,500- and 3,000-ft. levels. A new stope has been raised from the 11th level to the 850-ft. level and is producing the best grade of ore so far found in the mine. The management is said to be considering plans for increasing the milling capacity. The Kirkland Gold Belt is installing a new mining plant capable of carrying the three-compartment shaft to a depth of 1,250 ft. Since operations were commenced in June good ore values have been encountered on the 125- and 250-ft. levels.

Other Ontario Gold Fields.—In the Matachewan area the Ashley has put down a shaft to a depth of 570 ft. and established levels on four horizons. The mill of 150 tons capacity has been in operation since August and recently the first shipment of bullion valued at $20,000 has been made to the Ottawa Mint. On the property of the Bloom Lake Consolidated mines in this area surface exploration has exposed several large gold-bearing veins and a diamond drilling campaign has been started. The Parkhill in the Michipicoten field has installed a new electric hoist, and will continue the shaft to a depth of 750 ft. and two new levels will be opened up at depth. The mill is handling about 55 tons daily and production is carrying development and all mining costs. Vickers

Mines, Ltd., has taken over and is developing the Ontario Champion Mines in the Kenora district, where earlier work disclosed free gold on the surface and the 100- and 200-ft. levels. The Howey, in the Red Lake area of Patricia district, during the 10 months ended October produced approximately $950,000, the mill handling 28,000 tons per month. The operating profits for the 10 months were estimated at about $400,000 and the cost of operations was only a little over $2 per ton. Ventures, Ltd., has taken option on the Couchenor-Willans group of claims in the Red Lake area on which a large low-grade deposit has been located and where a diamond-drilling programme will be carried out.

North-Western Quebec.—The operating statement of Noranda Mines for the quarter ending September showed a marked falling off in the production of gold. The recovery amounted to $1,720,000, premiums of $208,000 bringing the total up to $1,928,000, as compared with $2,405,000 for the previous quarter. Net earnings were $779,046, as compared with $949,346. The management of the Granada has decided to increase the capacity of the mill to 300 tons per day by the installation of a Hadsell mill, which will be the first of its kind to be installed in Canada. During the month of October Siscoe Gold Mines treated 5,618 tons of ore of an average grade of $14·53 per ton and produced bullion to the value of $80,351, which compares with 5,249 tons treated in September, averaging $15·46 to the ton. The shaft has been completed to the 1,000-ft. level and development is proceeding on the 725- and 850-ft. levels. Good progress is being made with the construction of the mill addition and a Diesel engine has been installed to furnish power. The Tonawanda mines has taken a crew of men into its property in the Cadilac district and an active campaign will be carried on during the winter. At the Pandora development has been attended by highly encouraging results in the opening-up of veins showing free gold. A rich find has been made on the McWatters claims several miles east of Noranda.

Manitoba.—The Hudson Bay Mining and Smelting Company despite the low price of copper continues to operate its Flin Flon plant at capacity with a recovery of the precious metal sufficient to ensure a profit. About 4,000 tons of ore a day are being handled and it is estimated that this year's production of copper will amount to about 37,000,000 lb., the zinc output should reach a total for the year of 45,000,000 lb., the gold about $2,000,000, and the silver $300,000. The blister copper is being shipped to the refinery at Montreal east and finds a ready market. Practically all the zinc produced goes to Europe and being of high grade draws a premium above the market price. The Oro Grande Development Company has been maintaining an active development campaign on its property in the Bull Dog Lake area of Central Manitoba. At the Island Lake property the results of development are sufficient to justify the erection of a mill.

VANCOUVER

November 10.

Rossland.—The Velvet mine on Sophie mountain has been re-opened by a Spokane organization headed by Geo. Coryell Jr. and a crew of 25 men is employed on development and in making preparations for renewed production. The property was located originally in 1896 and was acquired by an English company represented by Sir Charles Tupper in 1897. The mine was operated for a period of about six years, having been worked subsequently on lease by various parties. In 1918 Granby Consolidated Mining, Smelting, and Power Company took an option and carried out some diamond drilling work, in the course of which some good sulphide ore is reported to have been located. The property was acquired in 1921 by the Rossland Velvet Mines, Ltd., and a 1,730-ft. drainage tunnel was driven, by means of which the workings that had been carried to a depth of about 500 ft. from a shaft were unwatered. Ore carrying high values was found in the oxidized zone down to the third level and good sulphide ore was worked on lower levels having an average content of about 0·5 oz. gold per ton with 1·9% copper. During the earlier periods of the life of the mine shipments of crude ore were made, but operations were costly and transport difficult. Later, a water concentration plant was installed, but returns were not very encouraging. The mine has been closed down since 1926. The present operators are installing a modern treatment plant and, with considerably improved conditions of transport and power supply, there is believed to be a good prospect of profitable operation.

Lillooet.—Recent advices from the Big Slide property on Kelly Creek are to the effect that rumours that have been in circulation in regard to immediate construction of a treatment plant are without foundation. The property was reported upon favourably by W. J. Elmendorf for Seattle interests, but it is understood that apart from sinking a winze there have been no developments to warrant expenditure on mill construction at the present time. A seam of good-looking ore about one foot wide has been opened up in the vein upon which the winze has been sunk to a depth of 55 ft. below the No. 3 tunnel, but such occurrences are not uncommon and the old tunnel workings which have been re-opened do not disclose evidence of any notable tonnage of ore.

Coast.—Attention has been directed recently to lode-gold possibilities in the Zeballos River area of Vancouver Island by a report that has been issued of Dr. H. C. Gunning of the Geological Survey. Prospecting was active in this area in 1929, when about 40 claims were staked up the valley of this river, which empties into Espinoza Inlet on the west coast of the island. On one claim owned by H. Malmberg and C. Nordstrom ore carrying 40 oz. gold per ton was found in a small stringer. This claim was bonded by A. B. Trites of Vancouver. The Marks Gold and Copper Company, Ltd., of Vancouver owns another group about six miles from tidewater and during the past two years prospectors have been working around the headwaters of the river. The country is rugged and heavily timbered and developments have been slow. Geological reports indicate that there are good prospects of developing ore in a belt of schistose rocks about 200 ft. wide and that exceptionally high values are recovered from a number of narrow veins.

Boundary.—An intensive programme of testing work is being carried out on placer ground in the valley of Rock Creek by Rock Creek Consolidated Placers, Ltd., an organization representing Penticton and Greenwood interests. A. G. Langley is the consulting engineer and he has outlined the work of tunnelling through the bench areas with the object of proving up certain possibilities in connexion with old channels. The creek was worked as far back as 1860, when an official production amounting to $83,000 was recorded. One-ounce nuggets have been obtained from shallow workings and it is said that over a considerable period returns of from $15 to $22·50 per man per day were obtained from sluicing work. P. B. Freeland, resident mining engineer for the district, reported in 1931 that only the gold from the more easily worked alluvial gravels had been extracted and that there still remained important stretches of the present creek gravels and also old, high, buried channels to be explored. It is understood that, if the results of the present investigations are satisfactory, a three and a half mile flume will be constructed from Couble Lake with a view to hydraulicking operations on an extensive scale. Recent reports are to the effect that the prospects for the discovery of an old channel are not as good as was anticipated, but there is much ground to be explored. R. L. Clothier is reported to have acquired an interest in the Morning Star, Evening Star, August, and Black Diamond claims in the Fairview camp and to be planning to re-open the old workings. The Carmichael group is also said to have been acquired by Vancouver interests. Development was active in this camp in 1898 and it it believed that there are large reserves of low-grade gold ore that can be blocked out and made to pay by the application of modern methods of treatment. The nucleus of the ore-bearing area, including the Stemwinder property, is controlled by the Guggenheim interests, and it is felt generally that the best prospects of the camp lie in the direction of unified control and large-scale operations.

East Kootenay.—Placer mining on Perry Creek has been stimulated by the announcement that T. B. Grady of Vancouver has acquired the property of J. Leask and W. P. Ratcliffe, on which there are favourable opportunities for the development of a large-scale hydraulic operation. The property was recently leased by A. Hurry, through whom Mr. Grady became interested. It is understood that a sum of $10,000 is to be expended in tunnelling work. Water supply is provided for already by a considerable length of pipe line and monitors are included in the existing equipment.

Salmo.—In an interesting report by B. T. O'Grady, the resident engineer for the Kootenay district, that has been released for publication recently, an account is given of developments in the Sheep Creek area. The outstanding discovery is said to have been made on the Gold Belt group, where an ore-body has been exposed on surface over a distance of 230 ft. The vein, which occurs in the Reno quartzite belt, is about 2 ft. wide

and shows visible gold. Preparations for active underground development are in hand. A considerable amount of trenching work has been done on the group of claims, and several other veins, belonging to the Nugget Motherlode series, have been uncovered. A number of other properties have been under development, including the Kootenay Belle, where regular shipments of gold ore averaging about $30 per ton are being made by F. M. Black and associates of Vancouver; The Queen, where C. E. Witter of Moscow, Idaho, has a crew of men working on the Alexandria vein, the ore being treated in the Queen mill; the Vancouver; and Columbia. The Motherlode mill of Reno Gold Mines, Ltd., is expected to be in operation this month, when production from the Reno mine will be resumed. Mr. O'Grady's report deals also with promising activities in the Nelson area and, in reference to the Eastern District generally, it is stated that 20 properties have shipped ore to the Trail smelter during the present season, 16 of which produced gold ore, the balance being Slocan mines, shipping a high-grade silver-lead product.

Portland Canal.—Individual activities that have been in progress on the extensive holdings of Dunwell Mines, Ltd., are said to have produced some encouraging results. J. W. Stewart and A. Bugnalo, who have been working on a partnership basis for the company, on the George E. claim have made recently a shipment of 10 tons of high-grade ore and are planning to continue work through the winter. Messrs. Jackson and Swedburg are working the Ben Ali claim on a lease, and Messrs. Younkin and McFadden are getting some good ore on the Sunbeam claim. It is reported that good ore has been struck on the Georgia River property, where the principal development has been in driving a cross-cut from the Bullion tunnel workings to the South-West vein. This cross-cut is said to have cut the vein at a vertical depth of about 260 ft. below the surface tunnel workings, where it is exposed, and samples are stated to have assayed $75 per ton in gold. A drive is being turned off on this vein from which a rise will be put up to connect with the workings above. Extension of this drive will develop backs of about 400 ft. This development is the most promising event that has been reported in the lengthy exploration of this property and is calculated to afford a basis for the estimation of ore reserves of an important amount. There are several showings on the property and working places have been scattered in the attempt to explore possibilities in connexion with large low-grade ore-bodies and narrower veins carrying high values in places.

Lardeau.—Work on the properties on Lexington mountain that were amalgamated recently under one control by Meridian Mining Company of Vancouver has been started. The properties include 32 claims and, as reported previously, were individually responsible for a considerable production several years ago. Development work, which will be commenced as soon as the new hydro-electric installation is completed, will be continued throughout the winter and is to be confined in the first place to two veins on the Eva group, on which there has been already an amount of over 5,000 ft. of underground work done. It is reported that a sum of approximately $45,000 is to be expended upon the immediate programme of construction and development, upon the results of which will depend the future policy to be adopted. It is anticipated that a flotation plant will be installed next spring. Meridian Mining Company is capitalized at $600,000.

Omineca.—The "Porphyrite" group of claims on Bob Creek in the Owens Lake section owned by M. Fenton, G. W. Smith, and C. Kelly has been acquired by A. J. McPherson and C. Stratford of Vancouver and it is understood that the terms of the contract call for the erection of a 20-ton mill next summer. The property has attracted a considerable amount of attention in recent years on account of the prominent exposure of mineralized ground. The occurrence is situated on what is termed locally the porphyrite dyke, which has been described as a highly-altered volcanic tuff, in which there is abundant disseminated mineralization in addition to a series of intersecting small veins from one half to two inches wide, carrying quite high values in gold. The formation is exposed in a canyon of the creek and has been referred to as being probably the source of placer gold that is found further down-stream. The property has been described by the resident engineer for the district as one possibly justifying close scrutiny. It is said that the erection of a mill at the property of Columario Mines, Ltd., near Usk, is under consideration. The property comprises the Kleanza and Valhalla groups of claims on which there is a series of gold-copper veins that have been under development for some time. The veins are

exposed on the western slope of Kleanza mountain within a belt about 1,250 ft. wide and vary in width from a few inches to six feet.

Bridge River.—In a brief review that has been published recently Geo. A. Clothier, the resident engineer, summarizes the developments in the Bridge River area during the past season as follows. The property of Bralorne Mines, Ltd., has outstanding possibilities, encouraging results have been obtained in the development of the King vein, and there is a wide field for extended exploration. The Pioneer has reached the status of a real mine and the monthly production of between $65,000 and $75,000 will be increased threefold immediately. Bridge River Exploration Company did not achieve much success, but there are unproved possibilities and nothing of great importance was developed in the south-east section of the camp despite an unusual amount of prospecting work. Prospecting in this section is rendered difficult owing to the depth of overburden and it is believed that there are good chances for better results next year when the surface operations are resumed.

Queen Charlotte Islands.—The Skidegate Sunrise property which is being opened up by Kitsault Eagle Silver Mines, Ltd., is said to be responding well to development. Although ore reserves are limited to the Main vein on which there is estimated to be an amount of about 4,750 tons blocked out, of an average value of $12·30 per ton, there are stated to be important possibilities in connexion with the Big vein that was discovered more recently. This vein has been exposed in surface workings only up to the present time, but maintains an average width of about 20 ft. in all the open-cuts that have been made over a length of 400 ft. and gold values are encouraging. A third vein known as the Sump vein has been cut in cross-cuts but has not been drifted on.

Cariboo.—Milling operations are expected to be commenced by Cariboo Gold Quartz Mining company during the present month. The mill has a capacity of 75 tons per day, which may be increased shortly to 100 tons. The average value of the ore is calculated to exceed $15 per ton. Developments on two of the eight veins that have been cut in the long cross-cut are reported to be highly satisfactory. The company is capitalized at $2,000,000.

PERSONAL

W. Baddeley Adams has returned to Abyssinia.
D. M. Baird is home from Sierra Leone.
G. C. Barnard has left for Kenya.
J. Macintosh Bell has returned to Canada.
Alfred Boyes is now in Malaya.
A. O. Brown is here from Portugal.
W. F. Dixon has left for Johannesburg.
A. I. George is returning from the Gold Coast.
O. T. Gorton is now in Kenya.
P. Ivanoff is here from Greece.
P. R. Lake has left for Abyssinia.
T. P. Larken has left for the Gold Coast.
P. R. McCarthy has returned to Nigeria.
G. B. Mackenzie has left for the Gold Coast.
P. E. Marmion left last month for Burma.
H. R. Mitchell has returned to Nigeria.
W. Murray has returned from Burma.
John A. Nogara is returning to Italy.
T. F. O'Sullivan is returning from the Gold Coast.
Thomas Pryor has returned from an extended tour of the Argentine and South Africa.
W. H. Trewartha-James has left for Western Australia.
A. R. O. Williams is returning from Northern Rhodesia.
Ernest Williams has returned to Western Australia.

John Henry Johns, who died at the age of 74 on November 23 at Bordighera, was one of the early Rand engineers. After leaving the Royal School of Mines in 1881, he was appointed superintendent of the Nine Reefs Gold Mining Co., in the Kolar field, India, and proceeded to South Africa in 1889 to become general manager of the Ferreira Gold Mining Co. About this time also Mr. Johns was consulting engineer to the Worcester Exploration and Gold Mining Co. and he acted in a similar capacity for the Johannesburg Consolidated Investment Co. from 1902 until his retirement in 1910. Mr. Johns was a member of several institutions, including that of Mining and Metallurgy.

TRADE PARAGRAPHS

Denver Equipment Company, of Denver, Colorado, U.S.A., have appointed **Messrs. Knapp and Bates,** of 840, Salisbury House, London, E.C.2, as their representatives.

Dressing and Screening Co., Ltd., of Alfreton, Derbyshire, issue leaflets describing their products, which include perforated metal and woven wire screens. Among the latter attention is drawn to spring-steel woven wire, which is recommended as being suitable for vibrating screens. Attention is also drawn to metal conveyor belts for heavy duty.

Sir Isaac Pitman and Sons, Ltd., of 39, Parker Street, W.C. 2, have published parts 2, 3, and 4 of *Engineering Educator* to which attention has already been directed in the Magazine. These issues contain further chapters on mathematics for engineers, the use of the slide rule, the first chapter on machine construction and drawing, and drawing office practice.

Askania-Werke, A.G., of Bambergwerk Kaiserallee 87–88, Berlin-Freidnau, Germany (London Representative: **O. G. Karlowa,** of Abford House, Wilton Road, S.W. 1), announce that Dr. Krahmann, whose work in the prospecting of the West Rand is referred to by the Johannesburg correspondent in this issue, made use of one of their magnetic variometers in the course of his survey.

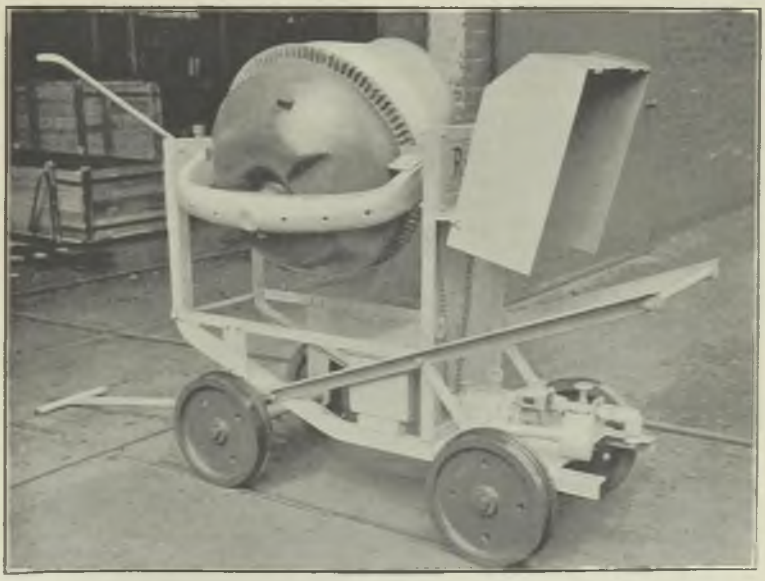
Thos. Firth and John Brown, Ltd., of Sheffield, have recently shipped to the order of Trinidad Leaseholds, Ltd., the largest steel forging ever made in the shape of a reaction chamber, which is to be used by the owners in the distillation of Regent motor spirit. The chamber, which is some 50 ft. in length and 6 ft. in diameter with walls 3¾ in. thick, was made from a steel ingot weighing 170 tons. When in use it will contain oil and vapours under a pressure of 400 lb. per sq. in. at a temperature of about 1,000° F.

Sir W. G. Armstrong Whitworth and Co. (Engineers), Ltd., of Thames House, London, S.W. 1, held a demonstration on November 21 of four newly-completed 1,700 b.h.p. Diesel-electric locomotives built for the Buenos Aires Great Southern Railway. 40- and 15-ton oil-electric shunting locomotives were also shown in operation and a 250 b.h.p. locomotive was used to haul the train from Newcastle to the works and back again. New types of Armstrong-Saurer heavy-oil-engined commercial vehicles were also shown in production and operation.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, publish a new catalogue describing their stone breaker and ore crusher. This is an all-steel machine of the jaw type, the jaw face and other renewable wearing parts being made of "Era" manganese steel. Particulars are given in the catalogue of the different sizes in which the breakers are made with the corresponding capacity and power consumption and there are cross-sectional elevations indicating the moving parts. A particular feature is the relief spring underneath the Pitman, which relieves the bearing pressure once per revolution and greatly assists the flow of lubricant. Mechanical lubrication can be fitted if desired at a slightly increased cost.

Drayton Regulator and Instrument Co., Ltd., of West Drayton, Middlesex, issue a leaflet describing their water and oil separators for use with compressed air. These are for installation as close as possible to the point at which the air is used. The separators are standardized in the most useful sizes ¼ in. to 3 in., and those in sizes of ½ in. to 1 in. can be supplied from stock. They work on the principle of liquid elimination by centrifugal force, i.e., the air passes at high velocity through a long spiral passage so that water and oil (if any) are thrown by centrifugal force against the wall of the container, from where they flow to the bottom by gravity. Ample storage space for a full day's continuous work is provided, but water should be drawn off daily.

Ransomes and Rapier, Ltd., of Ipswich, have modified the smallest member of their range of concrete mixers to meet a demand that they believe to exist among mining men for a machine of this description capable of mixing the concrete called for in a variety of operations, such as building of dams for grouting, for flooring, and for sub-station construction. The adaptation consists principally in the use of a 3½ by 5 Reavell air motor, in place of the standard petrol engine, operating at a pressure of 40 to 50 lb. per sq. in., a reducing valve being supplied for use when necessary. This form of drive is convenient for mines of all classes, but especially it is safe in fiery coal mines. The following are the brief particulars of the machine:—Its batch capacity (unmixed) is 4½ cu. ft., its output per batch (approximately) 3½ cu. ft., and its approximate output per



Ransomes and Rapier Concrete Mixer for Mines.

hour (based on 27 batches per hour) is 3½ cu. yds. The whole machine is mounted on four gauge wheels, suitable for 2 ft. gauge, which can be modified to suit existing conditions and is capable of passing through a doorway 3 ft. wide. As an alternative an electric motor may be fitted.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders :—For England : One 6 ft. by 36 in. Hardinge ball-mill for coal, one 6 ft. by 36 in. Hardinge ball-mill for ilmenite, one 6 ft. by 22 in. Hardinge ball-mill for primary grinding of manganese ore and graphite, one No. 00 Raymond pulverizer for sticky material used in dye manufacture, one No. 00 Raymond pulverizer for magnesia carbonate, and one 30 in. dia. Raymond mechanical air separator for ochres and oxides. For Scotland : One No. 00 Raymond pulverizer for grinding dry colours. For France : One 5-roller Raymond mill for phosphate and one Ro-Tap testing sieve shaker for laboratory work. For West Africa : One 2 X grit pump to deliver 100 U.S. gallons per min. containing solids and one 2 X grit pump for similar duty.

General Engineering Company, Inc., of Adelaide House, London, E.C. 4, issue particulars of the Geco continuous settling tank, which embodies a number of new mechanical features for effecting the stirring action. This is best understood by reference to the accompanying drawings, which show the application of the principle to both a circular (Fig. i) and to a square tank (Fig. ii). There is no central pier or column and the outlet for the discharging of solids is at the centre of the floor of the tank. The feed also is arranged to fall in the centre. The mechanism consists of a structure supported on wheeled carriages, attached to the ends of three radial arms, running on a single rail on the top of the wall, or periphery of the tank. One or more of the carriages is equipped with an electric motor and suitable reduction gear, the current being transmitted to the motor through collecting rings fitted to a mast running from the centre of the structure. In the illustrations such a motor is shown at A, the direction of rotation being indicated by the arrow. The power required to drive the mechanism of a 60-ft. settling tank is less than 1 h.p.

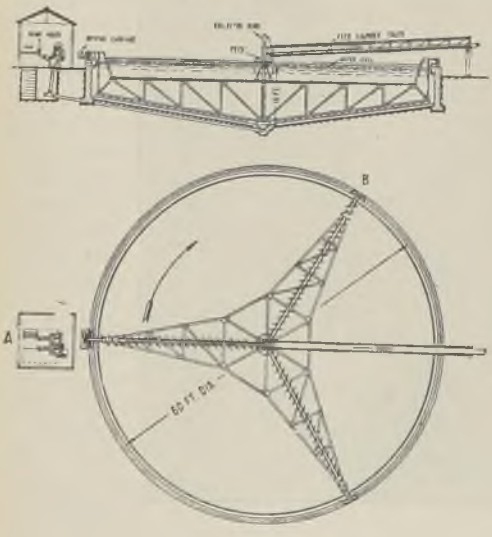


FIG. 1.

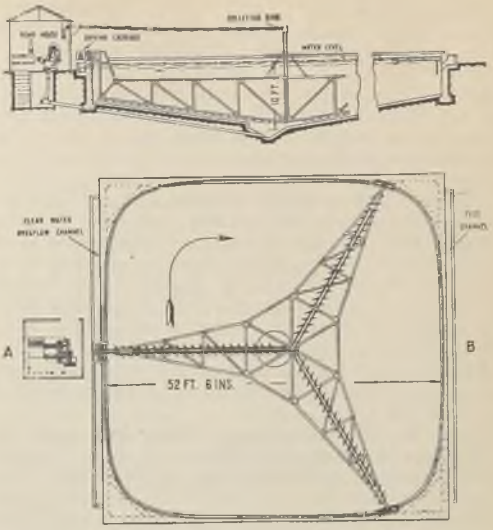


FIG. 2.

Buck and Hickman, Ltd., of 2–8, Whitechapel Road, London, E. 1, are giving demonstrations of electric welding with equipment made by the **Lincoln Electric Co.,** of Cleveland, Ohio. The essential feature of this method of arc welding is the " shielded-arc," an expression used to describe an area of inert gases surrounding the weld, which is achieved by means of the " Fleetweld " electrode coating. As a consequence of this effect, higher currents and voltage are safely used, which give a better weld, a greater speed of welding, and a minimum of slag inclusions. The use of considerably thicker electrodes is also made possible and electrodes are made in all the usual alloy steels as well as in other metals, such as aluminium. Booklets which they issue describing the method include references to the usual tests which weld parts have satisfied. The generating set used is of the self-contained type, generating 300, 400, or 600 amperes. The machine is entirely enclosed in arc-welded steel construction, rendering it drip-proof and secure against injury. One machine, with a petrol drive, is specially designed for outdoor conditions in rough country. Another booklet describes automatic arc welding particularly useful for large operations such as pipeline construction, roofing, etc. These machines are capable of both longitudinal and circumferential welds.

Scott and Strutt, Ltd., of 25, Victoria Street, London, S.W. 1, recently gave a demonstration to a number of interested engineers of the Morgon hot miller, the purpose and nature of which was described in the MAGAZINE for February, 1931. This machine is now being manufactured in this country and is obtainable either for belt-drive or direct-coupled to a high-speed electric motor. It has been in use in certain mines on the Rand for some time and important reductions in costs of drilling have resulted. For example, on the mines of one group the duty per bit sharpened was increased from 1·9 ft. in October, 1930, to 3·64 ft.

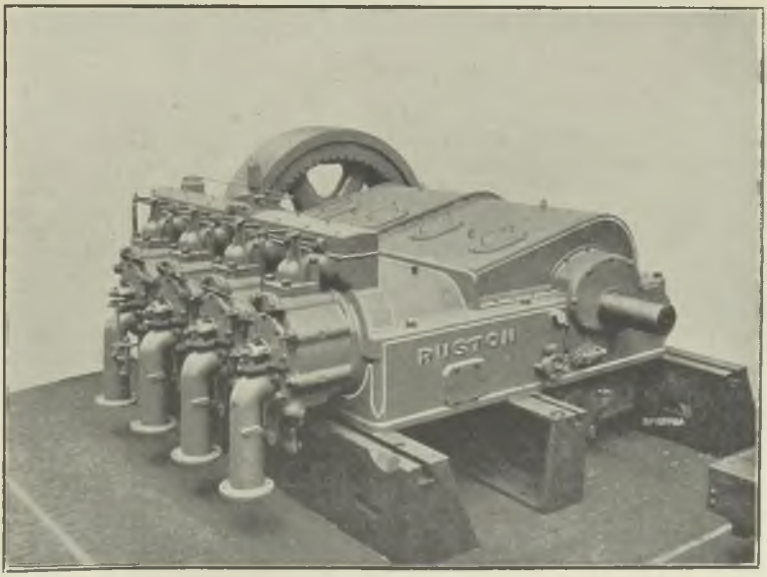
in October, 1931, a large part of the better results obtained being attributed to the use of the miller. Another result noticed on mines of the same group is an immediate reduction of the cost of rock-drill spares purchased in 1931 of 6·8%, although there has been an increase both in the fathomage broken and footage developed with no corresponding alterations in the prices. The milling cutters, which are made of a special steel, rotate at a high speed of the order of 3,000 r.p.m., the sharpening being done at a bright red heat corresponding to a temperature of the order of 850° C. As many as 120,000 bits can be made on a single set of cutters before they will require resharpening and they may be resharpened four or five times before it will be necessary to discard them, i.e., the average life of a set of cutters is usually well over 500,000 bits. The resharpening of the cutters is simply effected in much the same way as ordinary cold-milling cutters are sharpened. With regard to the output of sharpened drill steels the following are the results obtained by one of the large South African mining groups :—Prior to the introduction of hot milling and other alterations in practice the average number of 1¼-in. bits sharpened per 8-hour shift by one sharpening machine was from 700 to 1,000. The output now from one sharpener and one milling wheel is from 1,200 to 1,500 bits per shift and in one case, where the natives are exceptionally well-trained and every facility is provided, one sharpener and two wheels are turning out 3,000 bits per shift.

NEW RUSTON AND HORNSBY OIL ENGINE

A new type of horizontal crude-oil engine manufactured by Ruston and Hornsby, Ltd., of Lincoln, was demonstrated to the writer recently. Hitherto Ruston horizontal oil engines have been made in single- and two-cylinder units only, whereas the engine examined, and herein described and illustrated, has four cylinders. Four-cylinder horizontal gas engines produced by the firm have been in service for over 16 years and the success of these engines may be responsible for the extension of the oil-engine range. There appears to be no doubt that, under certain conditions, horizontal multi-cylinder engines have obvious advantages for mining power-generation purposes.

During recent years oil-engine design has generally tended towards the adoption of the vertical type, but mining engineers find that too great a height prevents its use underground or in confined spaces, where it is frequently difficult to accommodate the necessary lifting tackle clear of the vertical engine exhaust pipes. Obviously much less head-room is needed for a multi-cylinder horizontal engine, which has the further very definite advantage of being more quickly available for valve cleaning, etc., on occasions when repairs or inspection are carried out. In the case of the engine here illustrated the work of dismantling the valves can be commenced almost immediately after the engine stops running, there being no necessity to wait for much external cooling to take place. With a vertical engine that has been running non-stop for several weeks the periodic overhaul may be delayed some hours while the exhaust piping cools sufficiently to permit handling and removal. On the horizontal engine, too, the withdrawal of the piston is a simple operation not likely to take much time. In cases where there is a preference for a relatively slow-running engine the horizontal engine, with its comparatively long stroke, meets the demand. An engine of the type described is suitable for driving air-compressors, pumps, or electrical generators and, on account of its reliability and the low fuel and lubricating oil consumption guaranteed, is claimed by the makers to be a very inexpensive unit to operate.

With regard to maintenance the engine inspected



Ruston Four-Cylinder Horizontal Oil Engine.

is fitted with renewable cylinder liners, which, in the long run, minimizes the cost under this item. Lubrication of all the principal bearing surfaces of the engine is effected by the oil distributed under pressure, the bedplate being enclosed by means of readily detachable light steel covers. This is a feature which will appeal to all mining men owing to the havoc worked by dust and grit on open-type engines. Fuel is supplied to each of the four cylinders from one pump, which delivers the oil to a distributor, shown in the centre above the inlet-valve mechanism. The distributor ensures uniform loading of each cylinder and is specially suitable for use where unskilled or semi-skilled labour is available. Governing is effected by means of a spill valve. The timing of the fuel injection remains constant at all loads, but its termination is varied by the governor. In other respects the engine does not differ from the single- and twin-cylinder horizontal oil engines of the firm's manufacture, which are already well known. The unit is designed for an output of 264 b.h.p. at 265 r.p.m.

Mention has been made of the fact that the makers have for many years supplied multi-cylinder gas engines. If required the new range of oil engines can be made convertible so as to operate on fuel oil or on producer, town, natural, or sewage sludge gas, which may be available, by changing certain details. The makers' policy is to change important details such as cylinder head and to avoid the error of making the engines too readily convertible at the expense of efficiency when an engine is required to work on more than one class of fuel. Efficient operation on whatever fuel is available at lowest costs is thus ensured.

Whilst examining this engine the writer was also given an opportunity of seeing other horizontal oil engines and also vertical oil engines in the course of manufacture and was particularly interested in the making of such parts as atomizers and the components for fuel pumps and fuel distributors, also in the various tests employed at different points in the assembly to estimate the accuracy of sizes, weights, etc. Full details of this routine are contained in the catalogue published by the makers describing the Ruston oil engine, while another catalogue issued is devoted to the horizontal oil engine and gives full information concerning its construction and operation.

HUDSON MINE ROLLING STOCK

Robert Hudson, Ltd., of 38a, Bond Street, Leeds, draw attention to their products of interest to mining men. These include standard U- and V-shaped mining wagons, which are of the simplest design, made in capacities of 10 to 28 cu. ft. and have been adopted by mines all over the world. They are robust, being constructed to withstand extremely rough usage, and are described as being entirely trouble-proof on account of the omission of catches, etc. Two of these wagons are shown in the accompanying illustration in use on a South African gold mine.

HUDSON MINING TRUCKS.

Another product is the type of mining truck known as the Granby mine car to which attention was directed in an article in the MAGAZINE for August, 1931. These are generally of 100 to 180 cu. ft. capacity and of extremely heavy construction, the wheels being of high quality with ball or taper roller bearings, and invariably spring buffers and couplings of the automatic pattern are fitted. Other details are given in the article referred to.

Much attention has been paid by the makers to wheels and axles, having regard to the rigorous conditions of mine haulage, and special types incorporating high-duty bearings suitable for this service have been evolved, to which some attention was directed in the MAGAZINE for September, 1930.

The firm's products are very fully described and illustrated in the catalogue covering some 130 pages, of which they will be glad to send a copy to interested readers. This contains full details of products of the railway section, including rails and sleepers, accessories, points and crossings, turntables, etc.; of the locomotive section, which includes particulars of both steam and internal combustion engines; of the tipping-wagon section, which includes all types of contractors and mining

wagons, etc.; and a section devoted to the operation of light railways, which contains reference to various types of haulage.

ELECTRICAL PROSPECTING

A. B. Elektrisk Malmletning (The Electrical Prospecting Co.), of Stockholm, have recently discovered a new quartz reef in Sumatra by prospecting with their geo-electrical methods. The area in which the discovery was made is covered by young lavas of varying thickness. The topography is extremely rough and the jungle very dense, making prospecting work of any kind difficult. However, many years ago quartz boulders with gold values were discovered and the assumption that one or several quartz reefs exist in the andesite below the lava beds is therefore logical. Several years' prospecting by trenching and shaft-sinking gave completely negative results, as the lava beds were not even penetrated at any point. The Electrical Prospecting Co. was then employed with the object of locating areas where the thickness of the lava beds was slight and, if possible, also quartz reefs. A determination of the electrical properties of the rocks gave a specific resistivity of 5,000 to 10,000 ohm-cms. for the lavas and 50,000 to 150,000 for the andesite exposed in neighbouring areas. As the specific resistivity of quartz is more than 1,000,000 ohm-cms., it appeared possible to solve both problems mentioned above. The potential method described by H. Hedstrom in the April number of the MAGAZINE was employed and the results were gratifying, since an indication interpreted as caused by a high andesite ridge was soon obtained. Moreover, an indication on a poor conductor, interpreted as being likely to be quartz, was found within the andesite ridge indication. The electrical indications were obtained on a slope at an inclination of about 45° to the horizontal and to test the indications a bore-hole was drilled with an inclination of 45° (the inclination being, of course, opposite to that of the slope). After drilling about 20 m. andesite was encountered, proving that an andesite ridge actually exists and, after about further 30 m. drilling, a quartz reef was found in accordance with the prediction obtained from the electrical measurements. The Electrical Prospecting Co. has contracted with the Wiluna company to carry out similar electrical investigations for them in Australia.

METAL MARKETS

COPPER.—The copper market registered a moderate advance during November, producers seizing the opportunity presented by a spurt in the Continental demand to advance the quotation for electrolytic and standard values followed suit. On the whole, however, industrial buying has not been very brisk in Europe or on the Continent. The decline in sterling failed to force up standard copper prices on that account. The conference of producers in New York opened at the end of November and its decisions are awaited with interest. The date when the British import duty on electro will go into effect is uncertain at the time of writing.

Average price of Cash Standard Copper: November, 1932, £32 0s. 4d.; October, 1932, £31 18s. 7d.; November, 1931, £35 18s. 1d.; October, 1931, £35 0s. 1d.

TIN.—Prices moved up in the middle of the past month, thanks to influential support, but the rise was not maintained and on balance quotations are slightly lower. Apart from a well-maintained demand from British users in South Wales, inquiry from consumers has been rather subdued, although the American tinplate industry is more active than most trades on the other side of the Atlantic. The American automobile industry, of course, is still very depressed. The statistical position of tin is stationary, the world supplies in sight showing hardly any change during November and this fact is scarcely cheering.

Average price of Cash Standard Tin: November, 1932, £153 13s. 3d.; October, 1932, £151 7s. 6d.; November, 1931, £132 18s. 10d.; October, 1931, £127 0s. 9d.

LEAD.—Pretty steady conditions have prevailed, despite the bad statistical situation of the metal and the comparatively restricted demand from users. However, holders have been able to maintain a fairly firm attitude and have certainly not been disposed to press sales on an unwilling market. On the other hand, the weakness of sterling seems to have had no direct effect on London prices.

Average mean price of soft foreign lead: November, 1932, £12 4s. 7d.; October, 1932, £12 1s. 3d.; November, 1931, £14 10s. 8d.; October, 1931, £13 4s. 11d.

SPELTER.—This market also kept very steady during November on the whole, an upward movement during the middle of November gradually petering out. Business has remained quiet, but sentiment has been upheld by the knowledge that the statistical position is steadily improving. It is unlikely that the December meeting of the International Zinc Cartel will agree to increase the authorized rate of output, as suggested in certain quarters, although the situation is made a little complex by the German producers' application to their Government for a duty.

Average mean price of spelter: November, 1932, £15 7s. 11d.; October, 1932, £15 0s. 1d.; November, 1931, £14 0s. 10d.; October, 1931, £12 19s. 5d.

IRON AND STEEL.—The British iron and steel market is certainly in a more cheerful state than it was earlier in the year and there is talk of relighting more blast furnaces in the near future. Cleveland pig-iron prices remain nominally unaltered, with 58s. 6d. minimum asked for No. 3 foundry g.m.b., whilst hematite is steadier, East Coast mixed numbers being quoted at 59s. per ton. In the finished steel trade, business in semis formerly booked by Continental works is being diverted to mills in this country, whilst some fair foreign and home business in finished material has been received, including a good Finnish rail contract. Much interest has been created by the announcement that a big Bessemer steel plant and tube works is to be erected in the Midlands.

IRON ORE.—A few odd cargoes still represent all the business that is being done. Most works are more than adequately covered for the time being, illustrative of which is the fact that German ironmasters have concluded arrangements regarding the volume of their deliveries against contracts of Swedish ore during 1933. Nothing like the contracted quantity will be delivered unless there is a considerable expansion in activity in the steel trade. Meanwhile, best Bilbao rubio has advanced to 15s. per ton c.i.f. owing to the easier trend of sterling.

LONDON DAILY METAL PRICES.

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

	COPPER.						TIN.				ZINC (Spelter).		LEAD.			SILVER.		GOLD.
	Standard.				Electro-lytic	Best Selected.							Soft Foreign.		English.			
	Cash.			3 Months.			Cash.			3 Months.						Cash.	For-ward.	
	£ s. d.			£ s. d.	£ s. d.	£ s. d.	£ s. d.			£ s. d.	£ s. d.		£ s. d.			d.	d.	s. d.
Nov.																		
11	33 3 1½			33 6 10½	38 0 0	35 10 0	156 6 3			157 2 6	15 12 6		12 12 6		14 5 0	18⅛	18¼	125 0
14	33 8 9			33 13 1½	38 5 0	—	156 18 9			157 13 9	15 13 9		12 13 9		14 5 0	17⅞	18	123 2½
15	32 18 1½			33 3 1½	38 0 0	35 10 0	156 11 3			157 6 3	15 10 0		12 8 9		14 0 0	18	18⅛	123 11½
16	32 18 1½			33 3 1½	38 0 0	—	156 3 9			157 2 6	15 7 6		12 8 9		14 0 0	18	18⅛	124 2½
17	32 9 4½			32 13 1½	37 10 0	—	154 16 3			155 16 3	15 6 3		12 5 3		13 15 0	18⅛	18 3/16	124 10½
18	31 5 0			31 7 6	36 10 0	33 10 0	153 6 3			154 2 6	15 3 9		11 18 9		13 10 0	18⅛	18 1/16	125 7
21	32 3 9			32 6 10½	37 0 0	—	154 6 3			155 2 6	15 7 6		12 0 0		13 10 0	18 1/16	18¼	125 6
22	32 1 3			32 5 7½	37 0 0	34 5 0	153 8 9			154 11 3	15 7 6		11 18 9		13 10 0	18⅛	18¼	126 1
23	31 19 4½			32 4 4½	36 15 0	—	152 13 9			154 2 6	15 6 3		11 15 0		13 5 0	18⅛	18 3/16	125 10½
24	31 18 9			32 6 3	36 15 0	—	152 0 0			153 2 6	15 1 3		11 12 6		13 5 0	18 3/16	18¼	126 10
25	32 8 1½			32 15 7½	37 5 0	34 15 0	152 2 6			153 8 9	15 1 3		11 13 9		13 5 0	18⅛	18¼	127 8
28	32 6 3			32 13 1½	37 5 0	—	151 8 9			152 18 9	15 0 0		11 13 9		13 5 0	17 15/16	17⅞	128 4
29	32 3 9			32 10 7½	37 5 0	34 15 0	150 12 6			151 17 6	14 17 6		11 13 9		13 5 0	17⅞	17 15/16	129 3½
30	32 4 4½			32 11 10½	37 7 6	—	151 16 3			153 2 6	15 2 6		11 1 3		13 10 0	17⅞	17 15/16	130 8
Dec.																		
1	31 10 7½			31 16 10½	37 0 0	—	151 11 3			152 18 9	15 1 3		11 15 0		13 5 0	17 13/16	17 15/16	127 8½
2	31 13 1½			32 0 7½	36 15 0	34 5 0	151 16 3			153 3 9	15 6 3		11 18 9		13 10 0	17⅞	17 13/16	127 3
5	31 0 7½			31 8 1½	36 15 0	—	150 17 6			151 18 9	15 3 9		11 8 9		13 0 0	17 13/16	17 15/16	130 0½
6	30 15 7½			31 1 10½	36 5 0	33 5 0	151 18 9			152 11 3	15 2 6		11 6 3		13 0 0	17 15/16	17⅞	129 2
7	30 15 7½			31 3 1½	36 0 0	—	151 13 9			152 13 9	15 2 6		11 6 3		13 0 0	17⅞	17 13/16	128 1
8	30 1 10½			30 9 4½	35 5 0	—	151 18 9			152 13 9	15 1 3		11 5 0		12 15 0	17⅞	17 13/16	126 8
9	29 5 0			29 11 10½	34 15 0	31 10 0	150 6 3			151 8 9	14 17 6		11 0 0		12 10 0	17⅞	17 15/16	127 11

Antimony.—Although Chinese shippers remain fairly firm in their ideas, the paucity of business prevents the market from being very strong. Forward shipment from China is quoted at about £24 15s. to £25 15s. c.i.f., with spot about £27 ex warehouse. English regulus is now £37 10s. to £42 10s. per ton.

Arsenic.—About £20 to £20 5s. c.i.f. is named for Continental, with Cornish white nominally £22 to £22 10s. f.o.r. mines.

Bismuth.—Owning to exchange considerations the official price has been raised to 5s. per lb. for 5 cwt. lots.

Cadmium.—About 1s. 8d. to 1s. 9d. per lb. represents the present value.

Cobalt Metal.—The official quotation is unaltered at 7s. per lb. for contracts.

Cobalt Oxides.—Prices seem to vary rather widely according to quantity, black being quoted at from 4s. 9d. to 5s. 2d. per lb., with grey 5s. 4d. to 5s. 7d. per lb.

Chromium.—Metal is still priced at about 2s. 9d. per lb. delivered.

Tantalum.—Prices are nominally unchanged at £15 to £20 per lb.

Platinum.—The seasonal demand for platinum has been very small this year and the general appearance of the market is flat. Prices, however, remain at £9 to £9 10s. per oz.

Palladium.—Quotations stand at about £4 to £4 10s. per oz., business being slow.

Iridium.—Sponge and powder are steady at about £12 to £14 per oz. although demand remains trifling.

Osmium.—Quiet conditions prevail in this market at the unaltered price of £11 10s. to £12 10s. per oz.

Tellurium.—In the absence of any appreciable business, prices are quotably unchanged at 20s. per lb.

Selenium.—High-grade black powder is moving steadily at about 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

Manganese Ore.—There is very little to report in this market. A few inquiries are about for 1933 delivery, but hardly any actual business has been placed. Prices are steady at about 9½d. per unit c.i.f. for best Indian and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian.

Aluminium.—Only a limited demand is in evidence for raw aluminium, but the price remains at £100, less 2% delivered for ingots and bars.

Sulphate of Copper.—Current quotations for English material are about £17 to £17 10s. per ton f.o.r., less 5%.

Nickel.—Although demand is not very brisk prices have been raised in accordance with the depreciation in sterling, leading interests now quoting £260 to £265 per ton according to quantity.

Chrome Ore.—The general appearance of the market is very quiet. Prices are fairly well maintained, good 48% Rhodesian ore being held for about 80s. to 85s. per ton c.i.f. and 55 to 57% New Caledonian for about 100s. to 105s. c.i.f. Here and there some cheaper parcels are heard of.

Quicksilver. — Demand in Europe continues rather slack, but prices have been advanced here owing to the exchange, spot metal being held for about £11 5s. per bottle, net.

Tungsten Ore.—The market presents an uninteresting appearance, sales being few. China is offering forward shipment at about 11s. per unit c.i.f., but buyers' ideas are lower.

Molybdenum Ore.—With practically nothing offering prices are nominal at about 42s. 6d. per unit of metal c.i.f.

Graphite.—Dull conditions prevail here, but prices are nominally unchanged at about £17 to £19 c.i.f. for 85 to 90% raw Madagascar flake and £15 to £17 c.i.f. for 90% Ceylon lumps.

Silver.—November was a very dull month in the silver market. Spot bars stood at 18 3/16d. on November 1 and during the first half of the month moved within very narrow limits. The Continent was a seller on a small scale and on November 14 the price was 17⅞d. Subsequently fairly steady conditions continued, despite the erratic movements of sterling. On November 30 spot bars closed at 17⅞d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
November, 1931	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
November	930,085	48,631	978,716

TRANSVAAL GOLD OUTPUTS.

	October.		November.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	109,000	£158,013	113,000	£163,603
City Deep	81,000	21,233	80,000	21,176
Cons. Main Reef	74,000	24,745	70,500	24,374
Crown Mines	285,000	89,775	279,000	90,016
Daggafontein	44,200	£73,212	46,600	£78,203
D'rb'n Roodepoort Deep	52,000	15,985	50,200	15,475
East Geduld	63,300	20,627	62,800	20,475
East Rand P.M.	162,000	42,613	159,000	41,666
Geduld	86,600	27,743	84,000	27,157
Geldenhuis Deep	79,600	17,703	75,200	17,076
Glynn's Lydenburg	7,400	2,684	7,100	2,703
Government G.M. Areas	208,000	£405,451	208,000	£403,184
Kleinfontein	52,500	10,102	51,300	£42,287
Langlaagte Estate	78,000	£104,088	79,000	£103,361
Luipaard's Vlei	35,100	£37,211	33,400	£35,444
Modderfontein New	176,000	62,931	172,000	62,363
Modderfontein B	78,000	21,745	75,500	20,855
Modderfontein Deep	44,600	21,519	44,500	21,167
Modderfontein East	76,000	22,310	76,000	22,241
New State Areas	87,000	£181,211	90,000	£185,103
Nourse	72,000	21,200	71,000	20,910
Randfontein	250,000	£300,914	240,000	£292,002
Robinson Deep	98,500	28,369	98,000	27,985
Rose Deep	62,800	12,476	61,250	12,697
Simmer and Jack	81,300	22,466	76,600	21,879
Springs	79,600	£162,586	80,000	£162,775
Sub Nigel	37,300	33,468	36,700	33,258
Transvaal G.M. Estates	19,100	5,588	18,500	5,690
Van Ryn	51,500	£47,934	50,000	£46,646
Van Ryn Deep	71,000	£93,217	71,000	£92,729
West Rand Consolidated	96,500	£106,220	94,000	£104,743
West Springs	77,500	£78,496	79,500	£80,464
Witw'tersr'nd (Knights)	72,000	£56,972	70,000	£56,435
Witwatersrand Deep	46,100	15,028	45,400	£47,922

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
August, 1931	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	2,940,800	27 6	19 1	8 5	1,234,584
October	—	—	—	—	1,263,274

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
November 30, 1931	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	216,298	11,353	—	227,651
November 30	219,024	11,207	—	230,231

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	50,416
November	46,219	44,351	44,516	—
December	46,829	46,485	50,034	—

RHODESIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,400	9,618	25,600	9,598
Globe and Phœnix	6,102	6,258	6,038	5,813
Lonely Reef	9,400	2,239	9,500	2,225
Luiri Gold	—	—	—	—
Rezende	6,500	2,560	6,500	2,546
Sherwood Star	4,800	£7,971	4,800	£6,315
Wanderer Consolidated	15,700	3,511	15,300	3,512

WEST AFRICAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	7,095	£21,768	7,623	£23,932
Ashanti Goldfields	13,412	14,719	13,210	14,724
Taquah and Abosso	10,474	3,145	10,132	3,177

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
November, 1931	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	—	1,160
October	51,236	—	—
November	—	—	—

† Jan., Feb., and March.

AUSTRALASIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,082	6,257	5,331	5,746
Blackwater (N.Z.)	3,652	2,019*	3,750	2,061
Boulder Persev'ce (W.A.)	10,107	18,452	7,073	13,728
Grt. Boulder Pro. (W.A.)	7,604	5,513*	7,403	5,186*
Lake View & Star (W.A.)	31,576	42,062	—	—
Sons of Gwalia (W.A.)	11,050	15,559	12,258	15,523
South Kalgurli (W.A.)	10,128	15,099	—	—
Waihi (N.Z.)	18,043‡	5,851 * 30,763†	—	— —
Wiluna	28,015	3,099*	—	—

* Oz. gold. † Oz. silver. ‡ To Nov. 12.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	October.		November.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,340	5,675	9,100	5,674
Mysore	14,903	7,722	14,400	7,470
Nundydroog	15,315	8,714†	18,330	9,610*
Ooregum	12,020	4,343	11,553	4,134

* 1,764 oz. from 1,553 tons Balaghat ore. † 1,501 oz. from 1,872 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	October.		November.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	61,222*d*†	—	—
Chosen Corp. (Korea)	10,290	15,062	9,680	15,431
Frontino Gold (C'lbia)	3,460	14,312	3,320	16,580
Fresnillo	79,087	4,304*d*‡	—	—
New Goldfields of Venezuela	9,047	2,478*	9,644	2,070*
Oriental Cons. (Korea)	—	74,260*d*	—	71,125*d*
St. John del Rey (Brazil)	—	39,000	—	35,000
Santa Gertrudis (Mexico)	20,448	10,478*d*	—	—
Viborita	—	—	—	—
West Mexican Mines	1,370	19,000*d*	—	—

d Dollars. * Oz. gold. † To Nov. 6. ‡ 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	2,273
May	2,276	November	2,242
June	2,491	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Ayer Hitam	32¾	107½	—
Batu Caves	—	—	—
Changkat	20	40	60
Gopeng	24½	—	—
Hongkong Tin	31½	29¾	65½
Idris Hydraulic	12	17¼	18½
Ipoh	26½	87½	67¾
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	113	156	125
Kent (F.M.S.)	—	—	—
Killinghall	32	52¼	35
Kinta	11½	—	—
Kinta Kellas	—	—	—
Kramat Tin	80	35	25
Kuala Kampar	—	—	27
Kundang	—	—	—
Lahat	11	16	12
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	52½	59½	59½
Malim Nawar	30	10	—
Pahang	78	78	78
Penawat	42	73½	—
Pengkalen	22½	—	—
Petaling	90	222	48
Rahman	—	—	—
Rambutan	4½	—	—
Rantau	—	—	—
Rawang	33	30	33
Rawang Concessions	25	16	25
Renong	7¾	18½	47
Selayang	—	12½	—
Southern Kampar	53½	94	62½
Southern Malayan	51½	50½	59½
Southern Perak	19½	57½	—
Southern Tronoh	17½	17½	18
Sungei Besi	—	—	—
Sungei Kinta	24	—	—
Sungei Way	38½	35¾	31½
Taiping	—	—	—
Tanjong	11¼	—	—
Tekka	39*	—	—
Tekka Taiping	22	—	—
Temoh	—	—	—
Tronoh	38½	38½	39
Ulu Klang	—	—	—

* 3 months to Sept. 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Anglo-Nigerian	17½	14½	12½
Associated Tin Mines	107½	109½	106½
Baba River	1	1	1
Batura Monguna	—	—	—
Bisichi	16	16	—
Daffo	—	—	—
Ex-Lands	23½	26	27
Filani	—	—	—
Jantar	9	12	—
Jos	7¾	7¾	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	11¾	12½	—
Kaduna Prospectors	5¾	6	—
Kassa	5	5	6
London Tin	76	77	74
Lower Bisichi	3½	—	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	4	4½
Offin River	—	—	—
Ribon Valley	9	11½	11½
Tin Fields	—	—	—
United Tin Areas	10	10½	11
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Anglo-Burma (Burma)	47	45	50⅝
Aramayo Mines (Bolivia)	129	123	124
Bangrin (Siam)	36½	77½	68½
Beralt	26½*	—	—
Consolidated Tin Mines (Burma)	140	116	90
East Pool (Cornwall)	41½	43¾	—
Fabulosa (Bolivia)	32	41	36
Kagera (Uganda)	25	25	—
Kamra	—	—	—
Malaysiam Tin	14½	14½	14½
Mawchi	208*	188*	213*
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	170½	164⅜	56½
South Crofty	53¾	54	56½
Tavoy Tin (Burma)	69	52½	61
Tongkah Harbour (Siam)	40	36	34
Toyo (Japan)	59½	54	54½
Zaaiplaats	10½	—	—

* Tin and Wolfram.

COPPER LEAD, AND ZINC OUTPUTS.

		Oct.	Nov.
Britannia Lead	Tons refined lead	4,007	—
	Oz. refined silver	94,594	—
Broken Hill South	Tons lead conc.	5,137	5,732
	Tons zinc conc.	5,688	6,233
Burma Corporation	Tons refined lead	5,880	—
	Oz. refined silver	508,208	—
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	400	400
	Tons yellow metal	513	506
Messina	Tons copper	734	869
Mount Isa	Tons lead bullion	4,873	—
Mount Lyell	Tons concentrates	6,285*	3,227
North Broken Hill	Tons lead conc.	4,210	4,440†
	Tons zinc conc.	4,340	4,500†
Rhodesia Broken Hill	Tons V_2O_5	30	30
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons blister copper	3,196	3,200
Sulphide Corporation	Tons lead conc.	1,660	—
	Tons zinc conc.	2,360	—
Trepca	Tons lead conc.	5,222	5,061
	Tons zinc conc.	7,587	7,513
Zinc Corporation	Tons lead conc.	5,820	5,814
	Tons zinc conc.	4,068	4,713

* Eight weeks to Nov. 2. † To Nov. 19.

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

		Sept.	Oct.
Iron Ore	Tons	102,906	167,537
Manganese Ore	Tons	1,492	2,763
Iron and Steel	Tons	107,108	163,190
Copper and Iron Pyrites	Tons	12,000	12,586
Copper Ore, Matte, and Prec.	Tons	969	1,598
Copper Metal	Tons	17,717	21,630
Tin Concentrate	Tons	1,819	2,951
Tin Metal	Tons	190	190
Lead Pig and Sheet	Tons	15,891	25,003
Zinc (Spelter)	Tons	5,374	3,872
Zinc Sheets, etc.	Tons	1,816	1,553
Zinc Oxide	Tons	52	30
Zinc Ore	Tons	2,089	24,376
Aluminium	Tons	215	259
Mercury	Lb.	88,159	158,694
White Lead	Cwt.	7,023	3,020
Barytes, ground	Cwt.	26,756	22,859
Asbestos	Tons	1,985	1,344
Boron Minerals	Tons	1,283	795
Borax	Cwt.	8,698	9,180
Basic Slag	Tons	—	1,000
Superphosphates	Tons	1,537	1,001
Phosphate of Lime	Tons	31,682	25,459
Mica	Tons	124	173
Tungsten Ores	Tons	395	357
Sulphur	Tons	6,493	2,746
Nitrate of Soda	Cwt.	29,817	—
Potash Salts	Cwt.	520,225	490,800
Petroleum: Crude	Gallons	38,353,144	27,856,461
Lamp Oil	Gallons	17,470,320	10,522,413
Motor Spirit	Gallons	74,807,552	84,368,036
Lubricating Oil	Gallons	6,187,380	5,190,126
Gas Oil	Gallons	7,038,319	9,400,980
Fuel Oil	Gallons	29,964,904	40,779,091
Asphalt and Bitumen	Tons	5,100	5,806
Paraffin Wax	Cwt.	74,908	96,157

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Sept.	Oct.	Nov.
Anglo-Ecuadorian	15,578	16,021	15,465
Apex Trinidad	48,650	50,750	44,970
Attock	1,397	1,523	1,622
British Burmah	3,662	3,724	3,443
British Controlled	40,171	38,691	—
Kern Mex	834	836	794
Kern River (Cal.)	2,275	2,891	3,000
Kern Romana	82	92	87
Kern Trinidad	1,545	1,810	1,549
Lobitos	23,912	24,803	23,700
Phœnix	105,139	106,949	86,333
St. Helen's Petroleum	4,678	4,127	4,130
Steaua Romana	108,507	114,295	—
Tampico	2,352	2,352	2,201
Tocuyo	1,230	1,221	1,255
Trinidad Leaseholds	28,600	28,000	27,450

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Nov. 10, 1932.	Dec. 10, 1932.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	10 6	12 9
Anglo-Egyptian B	1 12 6	1 12 0
Anglo-Persian 1st Pref.	1 9 6	1 4 3
,, ,, Ord.	2 7 6	1 13 9
Apex Trinidad (5s.)	1 0 9	1 0 9
Attock	10 6	10 0
British Burmah (8s.)	4 6	3 6
British Controlled ($5)	4 0	3 6
Burmah Oil	3 4 3	3 0 0
Kern River Cal. (10s.)	2 3	2 3
Lobitos, Peru	1 18 9	1 16 3
Mexican Eagle, Ord. (4 pesos)	7 3	7 3
,, ,, 8% Pref. (4 pesos)	7 0	6 9
Phœnix, Roumanian	11 6	11 0
Royal Dutch (100 fl.)	17 15 0	18 2 6
Shell Transport, Ord.	2 7 6	2 7 6
,, ,, 5% Pref. (£10)	11 12 6	11 0 0
Steaua Romana	9 0	9 0
Trinidad Leaseholds	2 13 9	2 11 3
United British of Trinidad (6s. 8d.)	4 6	4 3
V.O.C. Holding	1 13 0	1 11 9

PRICES OF CHEMICALS. Dec. 10.

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 1
,, 0·880 solution	per ton	15 10 0
,, Carbonate	,,	27 10 0
,, Nitrate (British)	,,	16 0 0
,, Phosphate, comml.	,,	40 0 0
,, Sulphate, 20·6% N.	,,	6 2 6
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.	2 1
,, ,, crystallized, 40°	per lb.	8
Carbon Disulphide	per ton	30 0 0
Citric Acid	per lb.	10
Copper Sulphate	per ton	16 10 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 10
Iron, Nitrate 80° Tw.	per ton	6 0 0
,, Sulphate	,,	1 15 0
Lead, Acetate, white	,,	32 0 0
,, Nitrate (ton lots)	,,	27 10 0
,, Oxide, Litharge	,,	29 10 0
,, White	,,	39 10 0
Lime, Acetate, brown	,,	9 0 0
,, ,, grey, 80%	,,	12 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 10 6
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	40 0 0
,, Nitrate	,,	30 0 0
,, Permanganate	per lb.	8½
,, Prussiate, Yellow	,,	8
,, ,, Red	,,	2 0
,, Sulphate, 90%	per ton	10 10 0
Sodium Acetate	,,	22 0 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 12 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 15 0
,, Roll	,,	11 0 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.	10½
Turpentine	per ton	62 0 0
Tin Crystals	per lb.	1 0
Titanous Chloride	,,	10¾
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:	Nov. 10, 1932. £ s. d.	Dec. 10, 1932. £ s. d.
SOUTH AFRICA:		
Brakpan	4 15 0	4 10 0
City Deep	13 9	12 0
Consolidated Main Reef	1 11 9	1 11 3
Crown Mines (10s.)	6 10 9	6 13 9
Daggafontein	3 7 6	3 5 0
Durban Roodepoort Deep (10s.)	1 3 0	1 1 3
East Geduld	4 8 9	4 6 9
East Rand Proprietary (10s.)	15 3	13 0
Geduld	5 8 9	5 8 0
Geldhenhuis Deep	12 6	11 6
Glynn's Lydenburg	12 6	—
Government Gold Mining Areas (5s.)	1 19 3	1 18 0
Grootvlei	1 13 0	1 13 0
Langlaagte Estate	1 3 0	1 2 3
Luipaard's Vlei (2s.)	5 6	5 6
Modderfontein, New (10s.)	2 8 9	2 10 6
Modderfontein B (5s.)	13 3	13 3
Modderfontein Deep (5s.)	17 0	18 9
Modderfontein East	2 5 0	2 7 6
New Kleinfontein	1 2 6	1 2 0
New State Areas	3 7 6	3 4 3
Nourse	19 0	18 3
Randfontein	2 5 3	2 3 9
Robinson Deep A (1s.)	15 0	16 9
" " B (7s. 6d.)	15 0	14 0
Rose Deep	8 3	7 3
Simmer and Jack (2s. 6d.)	4 3	4 0
Springs	4 16 3	4 16 9
Sub Nigel (10s.)	6 6 9	6 0 6
Van Ryn	14 0	14 3
Van Ryn Deep	1 3 9	1 1 9
Village Deep (9s. 6d.)	1 6	1 6
West Rand Consolidated (10s.)	18 3	17 9
West Springs	1 7 6	1 6 6
Witwatersrand (Knights)	10 0	9 0
Witwatersrand Deep	10 0	11 6
RHODESIA:		
Cam and Motor	2 11 9	2 10 0
Globe and Phœnix (5s.)	18 0	18 0
Lonely Reef	15 0	12 6
Luiri Gold (5s.)	2 6	1 9
Rezende (17s. 6d.)	1 15 0	1 12 6
Sherwood Starr (5s.)	18 0	13 9
Wanderer	18 9	17 6
GOLD COAST:		
Ariston (2s. 6d.)	7 9	7 6
Ashanti (4s.)	1 18 6	1 19 9
Taquah and Abosso (4s.)	9 6	9 9
AUSTRALASIA:		
Associated Gold (4s.), W.A.	3 3	3 9
Golden Horseshoe (3s.), W.A.	4 3	4 0
Great Boulder Propriet'y (2s.), W.A.	7 9	7 6
Lake View and Star (4s.), W.A.	16 9	19 9
Sons of Gwalia (10s.), W.A.	15 6	14 9
South Kalgurli (10s.), W.A.	1 4 3	1 2 0
Waihi (5s.), N.Z.	18 6	17 9
Wiluna Gold, W.A.	2 7 6	2 1 9
INDIA:		
Champion Reef (10s.)	1 1 6	1 0 6
Mysore (10s.)	13 9	12 9
Nundydroog (10s.)	2 1 6	2 1 9
Ooregum (10s.)	7 6	5 9
AMERICA:		
Camp Bird (2s.), Colorado	6	3
Exploration (10s.)	3 0	2 6
Frontino and Bolivia, Colombia	1 2 0	1 6 3
Mexican Corporation (10s.), Mexico	4 6	3 6
New Goldfields of Venezuela (5s.)	5 9	4 9
St. John del Rey, Brazil	1 5 6	1 3 6
Santa Gertrudis, Mexico	6 3	4 6
Viborita (5s.), Colombia	4 3	4 4
MISCELLANEOUS:		
Chosen, Korea	7 3	8 0
New Guinea	5 0	4 6

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

LEAD-ZINC:	Nov. 10, 1932. £ s. d.	Dec. 10, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	1 1 0	19 9
Broken Hill, North, N.S.W.	2 18 9	2 15 0
Broken Hill, South, N.S.W.	1 18 9	1 16 3
Burma Corporation (10 rupees)	10 6	10 0
Electrolytic Zinc Pref., Tasmania	—	12 3
Mount Isa, Queensland	10 6	9 0
Rhodesia Broken Hill (5s.)	1 9	1 6
San Francisco (10s.), Mexico	8 6	7 3
Sulphide Corporation (15s.), N.S.W.	7 0	5 9
ditto, Pref.	10 6	8 3
Trepca (5s.), Yugoslavia	9 0	8 6
Zinc Corporation (10s.), N.S.W.	1 3 9	1 1 3
ditto, Pref.	3 5 0	3 7 6
TIN:		
Aramayo Mines (25 fr.), Bolivia	13 9	12 6
Associated Tin (5s.), Nigeria	4 6	4 3
Ayer Hitam (5s.), Malay	11 3	11 0
Bangrin, Siam	13 0	11 6
Bisichi (10s.), Nigeria	5 9	5 3
Consolidated Tin Mines of Burma	3 6	3 0
East Pool (5s.), Cornwall	9	9
Ex-Lands Nigeria (2s.)	1 3	1 3
Geevor (10s.), Cornwall	2 6	2 9
Gopeng, Malay	1 7 6	1 6 3
Hongkong (5s.), Malay	13 6	13 6
Idris (5s.), Malay	6 3	4 3
Ipoh Dredging (10s.), Malay	14 6	13 0
Kaduna Prospectors (5s.), Nigeria	5 0	5 0
Kaduna Syndicate (5s.), Nigeria	12 6	12 6
Kamunting (5s.), Malay	5 3	5 4
Kepong, Malay	7 6	7 6
Kinta (5s.), Malay	5 0	4 0
Kinta Kellas (5s.), Malay	4 6	3 6
Kramat Pulai, Malay	15 0	14 6
Kramat Tin, Malay	1 6 0	1 6 0
Lahat, Malay	—	5 0
Malayan Tin Dredging (5s.)	16 6	15 9
Naraguta, Nigeria	8 9	8 9
Pahang Consolidated (5s.), Malay	5 0	4 6
Penawat ($1), Malay	—	1 1
Pengkalen (5s.), Malay	8 3	8 0
Petaling (2s. 4d.), Malay	10 0	10 0
Rambutan, Malay	5 0	4 6
Renong Dredging, Malay	16 3	15 6
Siamese Tin (5s.), Siam	7 6	7 0
South Crotty (5s.), Cornwall	2 3	2 0
Southern Malayan (5s.)	9 3	9 6
Southern Perak, Malay	1 5 0	1 5 0
Southern Tronoh (5s.), Malay	5 6	5 0
Sungei Besi (5s.), Malay	7 0	7 0
Sungei Kinta, Malay	10 0	10 0
Tanjong (5s.), Malay	7 0	7 0
Tavoy (4s.), Burma	4 6	4 3
Tekka, Malay	10 0	10 0
Tekka Taiping, Malay	10 0	10 0
Temoh, Malay	10 0	10 0
Toyo (2s. 6d.), Japan	2 6	2 6
Tronoh (5s.), Malay	13 9	13 6
DIAMONDS:		
Consol. African Selection Trust (5s.)	16 9	15 0
Consolidated of S.W.A. (10s.)	4 9	3 9
De Beers Deferred (£2 10s.)	4 10 0	4 13 9
Jagersfontein	1 3 9	1 3 9
Premier Preferred (5s.)	1 10 0	1 5 0
FINANCE, ETC.:		
Anglo American Corporation (10s.)	12 9	11 0
Anglo-Continental (10s.)	3 9	4 0
Anglo-French Exploration	15 0	14 3
Anglo-Oriental (5s.)	6 0	6 0
ditto, Pref.	11 0	9 6
British South Africa (15s.)	16 6	15 6
Central Mining (£8)	12 7 6	12 2 6
Consolidated Gold Fields	1 18 9	2 0 6
Consolidated Mines Selection (10s.)	9 9	7 9
Fanti Consols (8s.)	8 3	8 3
General Mining and Finance	1 7 0	1 4 6
Gold Fields Rhodesian (10s.)	4 0	4 0
Johannesburg Consolidated	1 15 3	1 11 6
London Tin Corporation (10s.)	9 3	8 9
Minerals Separation	3 5 0	3 1 3
Mining Trust	4 3	4 0
National Mining (8s.)	10	6
Rand Mines (5s.)	4 5 6	4 3 0
Rand Selection (5s.)	13 9	11 6
Rhodesian Anglo American (10s.)	10 0	9 0
Rhodesian Selection Trust (5s.)	5 3	4 0
Rhokana Corp.	4 12 6	4 0 0
Tigon (5s.)	2 9	2 9
Union Corporation (12s. 6d.)	3 8 9	3 4 3
Venture Trust (6s. 8d.)	—	—

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.

AIR CONDITIONING IN DEEP MINES

Elsewhere in this issue our Johannesburg correspondent refers to a paper on air conditioning in deep mines, read by Dr. J. T. McIntyre before the South African Institution of Engineers. This paper is published in the *Journal* of the Institution for November and full extracts are given here. In his introductory remarks the author says that it appears that the question of proper air conditioning of the ventilating air supplied to the deep level mines on the Rand has now become a subject of paramount importance and requires immediate attention if mining is to be carried on at the great depths now anticipated. There is, of course, much more in the problem than the possibility of obtaining limiting conditions for work and the aspect of maintaining a condition conducive to efficient work is of first importance. A simple illustration of the direction in which success lies may be made by comparing a man with a steam turbine—the man works more efficiently as the temperature, humidity, and cooling power of the air approach certain known values, while the turbine does likewise by reducing the back pressure to the smallest possible amount.

Where the values are reasonably constant over wide areas the winning of ore for reduction to fine gold becomes essentially an economic problem of careful analysis of production costs. Thus, as the mines increase in depth, the greater is the winding distance for men and ore, so that the cost per ton of ore brought to the surface is continually increasing. The longer the time in getting men to and from the face means less time actually doing productive work, so that the efficiency should increase instead of decrease with depth. There is also the important consideration of alertness of the individual in the prevention of accidents, since rockbursts may possibly be more frequent with the increasing stress and brittleness of some of the rock at great depths. This last factor is sufficient in itself to merit a serious attempt to improve conditions to as near the ideal as possible and with more efficient work fewer men are required in the danger zones so that the probability of accidents may be diminished. With regard to the phthisis danger, it is reasonable to assume that an improvement in body condition will increase resistivity.

The effects of air condition on health and the efficiency of manual operation have been the subject of close study by various groups, and the joint paper by Dr. Orenstein and Mr. Ireland read before the Institution in 1921 gives much valuable information on local conditions.

The author then summarizes the conclusions of Orenstein and Keppel and goes on to say that the recently published report of the Industrial Health Research Board gives the latest tests on the effects of air condition, on manual efficiency, occurrence of accidents, etc.; these are summarized in *Engineering*, as follows :—

From tests on a group of 23,000 miners working at the collieries from a period of from two to six years, it was found that, while time lost from sickness by men working at dry bulb temperatures of 70° F. was 3%, where the temperature was between 70° F. and 79° F. the corresponding figure was 4·5%, rising to 5%, where the temperature exceeded 80° F. When the data were based on wet bulb temperatures, it was found that the time lost at a temperature below 66° F. was 3%, 4·2% at temperatures between 66° F. and 69° F., and 5% at temperatures above 70° F. The conclusion is drawn that the effect is mainly due to the sudden change experienced when the men are raised from the pit to the surface. It is interesting to notice that high temperatures do cause an increase in the incidence of accidents. Disablement lasting less than 10 days was more than four times as prevalent among men working at 82° F. than among those working at 64° F., and accidents resulting in up to 19 days' disablement were 80% more numerous at the higher figure. On the other hand, severe accidents, entailing an absence of more than 20 days, were only 20% more prevalent at the higher temperature. Any deductions that might be based on these statistics are somewhat vitiated by the fact that the numbers of these returning to work in less than four days are not recorded, and that the unpleasant thermal conditions have a tendency to encourage those affected to stay away for longer periods than are absolutely necessary, when they get the chance. It further appears that, while in temperatures of less than 70° F., the accident frequency is the same at all ages, over that figure the older men are more likely to be affected.

As might be expected these conditions have a harmful effect on output, the efficiency of production of 138 men working in two adjacent mines being 41% less when the dry bulb temperature was 86·2° F. and wet bulb temperature 79·3° F. and air velocity 10 ft. per minute, than it was with temperatures of 73·5° F. and 66° F. and air velocity 87 ft. per minute. The efficiency of ventilation is found also to affect the output of workers very largely. It is interesting to find, moreover, that the temperatures at which the lowest accident frequency and the maximum efficiency occur are not the same. The former may be placed at about 69° F., at which figure experience shows the efficiency and probably comfort are somewhat less than they are when the temperature is slightly lower. The above conclusions have been drawn from mines and factories in Great Britain extending over a period of years, but it is satisfactory to find that they are confirmed by researches made at the London School of Hygiene and Tropical Medicine by Messrs. H. M. Vernon and C. G. Warner.

These remarks indicate the importance of air condition on rates of manual labour and also show that a great deal of useful local information could

be obtained with experiments in a room with controlled air temperature, humidity, pressure, and velocity. It may even be suggested that hospital wards should be arranged for treatment of influenza cases, so prevalent on the Rand, in which a barometric pressure of 30 in. mercury and certain predetermined temperatures and humidity are maintained.

The methods of supplying conditioned air to the foot-wall drives, working stopes, and development ends forms the subject of this paper, which embodies the writer's opinions of what is possible in this direction. It is hoped that these considerations and analyses may be of value in helping to elucidate the problem of mining to depths of 9,000 and 10,000 ft. below the general ground level on the Rand. It is realized, however, that the supply of conditioned air in sufficient quantities to the men working underground only solves part of the problem of deep mining, but the writer feels that so many astonishing feats have already been accomplished by engineers on this field that they will not fail to get over any fresh difficulties which may crop up.

The writer is associated with mining engineering from the point of view of ventilation and heat transfer questions, but at the same time a knowledge of mining conditions has served to keep theory in line with practice. Also acquaintance with the mines in Britain, South Holland, and Belgium added to a varied experience on all kinds of land and marine questions of ventilation has assisted in forming the present opinions expressed on this problem.

The paper is divided into sections, as follows :—

(II) Path of Ventilating Air through Mine.—The path of the air from the downcast to the upcast shafts is described together with the present realizable conditions at the various points. These conditions are well known to those connected with the mines, but it has been considered worth while to review them here for the benefit of others interested.

(III) Natural Laws affecting Condition.—Rates of rock cooling, rates of heat transfer from rock to air under different conditions and the temperature rise of the air when passing through rock tunnels are given for conditions of elevated rock temperatures met with in deep workings. Temperature conditions are also analysed for lagged and unlagged pipes conveying liquid at a temperature below the surrounding air.

There is also given in this section a short résumé of the various methods of dust collection. The author says that the problem of reducing the amount of dust in suspension in the ventilating air was a very serious one at one time in the history of the mines and the incidence of phthisis due to this was reduced to a remarkable degree by regulations providing for the spraying of clean water on all places likely to cause dust. Rock drills were designed with hollow drill shafts, so that water could be carried to the source of the pulverizing of the rock into dust, and this water did not upset ventilating conditions so long as the rock temperatures were not very high. With deeper mining, however, the indiscriminate use of water very seriously affects the cooling capacity of the ventilating air and it is necessary now to cut down free moisture to the veriest minimum. Thus the spraying of water on the incoming splits is likely to raise dust rather than allay it, this being due to the surface tension of the water preventing the wetting of the fine dust particles. It is true, nevertheless, that water spraying of the stoping faces does entrap a certain amount of fine dust, which is attracted by the larger particles, and in this way it is wetted and is not picked up by the air during further handling of the material.

The four main methods for trapping fine dust are as follows :—

(*a*) Using fine cloth filters through which the air is pulled by a fan. The efficiency of collection varies from 90 to 99%, depending on the grading and number of cloths used.

(*b*) Wet filters using very dilute alcohol solution or a suitable oil, which is allowed to fall by gravity over exposed metal surfaces while the air passes horizontally through the filter.

(*c*) Electrostatic methods by which the dust particles are charged negatively and attracted to plates maintained at a positive potential from which they can be conveniently "charged" or washed off.

(*d*) By supersaturation of the air so that condensations of moisture form on the most minute of particles. The supersaturated condition of the air is essentially a transient phenomenon, so that it is never likely to happen in the general ventilating air unless its condition is changed quickly by some form of compression or expansion machine or cooler.

The amount of oxidation going on in mines depends entirely on the local conditions and it is only by careful tests that this may be properly determined. It is generally true that moisture assists rates of oxidation and it would be interesting to know to what extent it is influenced. Experiments of this nature will involve a careful quantitative analysis of the air at inlet and outlet from a suitable experimental section, and the reduction in oxygen and increase in CO and CO_2 carefully estimated, from which the extent of the heating in this way can be calculated.

(IV) Critical Analysis of Suggested Methods for Improvement.

(*A*) *Refrigeration on the Surface.*—This was probably the first method of improvement to be considered, but after investigation of the initial cost for a plant to deal with volumes of 300,000 cubic feet of air per minute for the desired amount of cooling, it was seen to be rather prohibitive. The figures for the refrigeration plant set up at the Morro Velho mine in South America give some idea of the costs involved for such a scheme. This was an ammonia installation on the surface with a guaranteed heat extraction capacity of not less than 100,600 B.T.U. per minute, which corresponds to a reduction from 72° F. to 43·2° F. wet-bulb temperature of 5,040 lb. of air per minute, i.e. about 80,000 cu. ft. per minute at the density prevailing at Morro Velho. The power to drive this plant would be approximately 600 k.w., and the capital cost was about £120,000, from which we can assess the cost per cooling B.T.U. on a 20 years' amortization.

Capital charge per annum . .	£6,000
Power running costs . .	8,700
Supervision and repair charges .	1,300
Total	£16,000

∴ Cost per minute = 7·35d.
Cost per cooling B.T.U. = 0·000073d.

If the costs were estimated on 15 years' amortization, this would increase to 0·000082d. These figures are based on operation for 24 hours per day during the whole year, so that they represent minimum values.

(*B*) *Refrigeration or Dehumidifying Underground.*—This system may be divided into two subdivisions: (1) cooling of the total amount of air passing to the splits; (2) cooling of only a fraction of the air for local hot spots. In either case the refrigerating substance used in the machine must generally be of such a character that it is not harmful if leakage takes place into the free air. Thus, under present circumstances we are practically limited to the use of the air itself or water as the refrigerant. The fundamental process involved in these underground refrigeration schemes is the transfer of heat from the incoming air to the outgoing vitiated air by creating a temperature difference in the circulating water.

(*C*) *Water Evaporation in a Closed System.*—A development from the water refrigeration scheme, which has probably been considered, is to allow water to pass through a restricted nozzle into a space which is kept at a very high vacuum by means of a condenser on the surface with condensate pumps and air pumps, and using cooling water at about 55° F. If an absolute pressure of about 0·25 lb./sq. in. could be maintained at the surface, then if all the pipes were perfectly airtight, a pressure of about 0·42 lb./sq. in. would be maintained in the expansion tank underground and a steam temperature of 75° F. The evaporation of the water underground and condensation on the surface would result in transference of heat from underground, since the ventilating air would pass around the expansion chamber and give up the heat necessary for evaporation. The necessity, however, of having a *completely steam-tight* pipe passing all the way from the point of application underground to the surface is, of course, the first big difficulty. This pipe would require to be about 4 ft. diameter for a cooling rate of 100,000 B.T.U. per minute with approximately 100 lb. of water circulating per minute. The water would also require to be distilled to remove the air in solution otherwise the vacuum could not be held. Thus it may be taken that such a scheme is impracticable.

(*D*) *Sub-Atmospheric Dehumidifier.* — Another development of the air dehumidifier which might be considered is a sub-atmospheric machine in which the air is reduced in pressure with a corresponding reduction in temperature and condensation of moisture, after which it is compressed back to atmospheric pressure. The principal difficulties with this type of machine are the large volumes to be handled for a comparatively small weight of air. This reduction in density also affects the performance of the air motor and blower, so that it is very doubtful if a coefficient of performance approaching unity would be attained.

(*E*) *Cooling by Cold Brine in Pipes.*—The use of a refrigerating machine has possibly been considered either on the surface or underground to cool off brine, which is then led in insulated pipes to the point of application. The difficulties, however, with this scheme are that with the long distances to be travelled, the cold is partially lost. Also, if these pipes are brought from the surface the pressure at depth will be very great unless it is broken by the use of Pelton wheels and pump sets, or some such arrangement and, of course, anything of this nature always tends to heat the liquid, due to the turbulence and vortices created.

This scheme does not appear to be too attractive, since the price of making cold will be the same as with any other method, and to that will have to be added the price of heavy piping, pumps, etc., while the advantages at the point of application will be always less than exist near the machine. Also the quantities of water circulated must be quite large, since it is only sensible heat which can be utilized.

(*F*) *Cooling by Ice.*—For local cooling this appears to offer quite a number of advantages, and Dr. Dobson showed that: Cost per cooling B.T.U. = 0·00015d. This is estimated on a large production basis, with ice costing 2·58d. per 100 lb.

(*G*) *Cooling Effects of Compressed Air.*—This has been very fully dealt with by Dr. Dobson, and his results were as follows:—

(*a*) By expansion from a nozzle—Cost per cooling B.T.U. = 0·00093d.

(*b*) By expansion in engines and made to do work — Cost per cooling B.T.U. = 0·00022d. It should be mentioned that Dr. Dobson has considered air being supplied at the surface at a gauge pressure of 110 lb./sq. in., and if 30 lb./sq. in. gauge pressure were used then the cost per cooling B.T.U. for (*a*) would be reduced approximately in proportion to the work done in compressing the air thus:—

(*c*) By expansion from 30 lb./sq. in. through nozzle — Cost per cooling B.T.U. = 0·0005d. This figure is influenced by the increased cost of the larger pipe required and also the slight reduction in the Joule-Thomson cooling effect. The minimum cost per cooling B.T.U. with freely expanding compressed air is reached when it is compressed by only a few inches of water-gauge pressure to force it through a pipe to the underground levels.

(*H*) *Refrigeration of the Rock Drill Compressed Air before being sent down the Mine.*—This has a very limited scope, and is not deemed sufficiently promising for discussion.

(*I*) *Use of Liquid Air.*—Dr. Dobson showed that the use of this would lead to a cost of about 0·004 per cooling B.T.U., which is very high indeed.

(*J*) *The Use of Solid Carbon Dioxide.*—The production of solid CO_2 is still in process of development on a large scale and reliable costs are not yet available.

(*K*) *Conservation of Evaporative Cooling Effect.*—The supply of a large volume of relatively dry air to mix with the nearly saturated air entering through the usual channels appears to offer very attractive possibilities. Such a scheme as this requires that a large diameter light sheet metal pipe from 6 to 10 ft. diameter depending on the volume passing, be taken the whole way from the surface to a point underground as near as possible to the branches for the working splits. This comparatively dry air would then be mixed with the nearly saturated air passing through the inlet section of the mine as at present, so that the evaporative cooling power would be of an order comparing favourably with that on the surface.

(*L*) *General Remarks.*—Thus one comes back to the point again which has been so much stressed by other writers on this subject, that in order to conserve cooling power at depth the driest conditions possible must be maintained. In the splits this may be done by covering up all drains and waterways, and when there is an egress of moisture

from the rock, this should be tapped and led off to the usual settling place for pumping to the surface. If it is going to be impossible to do away with the wetting of the stope faces, it will be necessary to adopt a system of mine ventilation control in which the air, after passing through one or, at the most, two stopes, is considered as entirely vitiated and is short-circuited to the exhaust system, and if stopes are being worked at a higher level, these should be separately fed from splits higher up on the incoming fresh air inlet system. The method of mining with foot-wall drives appears to offer many advantages from a point of view of air control, which is so essential for any efficient system of ventilation.

The writer understands, however, that the possibilities of dry mining are still being investigated, particularly since the suggestions embodied in Dr. Haldane's papers in 1929, recorded in the *Chemical and Metallurgical Journal*. In this connexion any experiments undertaken to reduce amount of water used must not risk the health of the men underground, and it appears that the use of respirators in the experimental areas might avoid this danger.

(V) Economical Methods for Improvement.—In this section the author gives a résumé of the improvements which may be effected in the existing system of ventilation and the mining methods which affect it, and to give the suggestions taken from the previous analysis, which appear to offer the best chance of success for future developments.

(*a*) From the analysis given it will be generally realized that the maximum amount of air possible should be circulated to the working stopes, and that the temperature rise of this air should approximate to the theoretical minimum. To do this air passages should be made as smooth and continuous as possible so as to preserve uniform velocity of the air current and keep down resistance for the velocities used, which will give minimum heating. Where restrictions are unavoidable, a diffusor or evasée construction should be attempted in the shape of the down passages so that the maximum of created velocity head is regained.

(*b*) The effect of reducing resistance is reflected in the amount of heating done by the fan if this happens to be placed on the inlet side.

(*c*) The efficiency of the fan also determines the rise in temperature of the air passing through, and considerable advantage can be obtained by the use of modern highly efficient propellor type fans in which the air current passes straight through with only a small change in velocity, and every part is streamlined so that the fan casing resistance is reduced to a minimum. A practical demonstration of these advantages was given when propellor type fans were fitted aboard ship for circulating air in the cooled fruit-carrying spaces. This fan generally took 50% or less power to drive it than the centrifugal type used previously for the same air volume circulated and, since approximately 40% of the refrigeration required was for taking out heat put in by the fan, it was possible in many instances to reduce the size of the refrigerating machine installed. Needless to say, these fans are now adopted as standard for this class of work.

(*d*) Where large power plant is operating underground, the air required to cool the machinery should be short-circuited to the upcast shaft. This circulation can always be rendered positive by the use of a suitably rated fan connected to a length of ducting when necessary.

(*e*) Low resistances mean low differential pressures and this in turn greatly affects the amount of leakage taking place at control doors, etc. There is, however, generally one source of leakage which has been permitted as unavoidable and that is where a drain passes through at such a control point. This leakage, however, may be conveniently avoided by a simple trap. Prevention of leakage is, of course, very essential in preserving the good condition of the ingoing air and restricting the temperature rise to a minimum.

(*f*) Reduction of free moisture to a minimum, but it is assumed that the prevention of fire is worthy of keeping the timber wet. Covering up all drains, etc., is a precaution which can be taken however, and in this connexion the writer understands that the presence of a leaking water-pipe in the Mysore mines of India is considered a crime, and is dealt with as such.

(*g*) Efficient wetting of the stoping faces under present conditions only at the beginning of the working shift. This wetting to be done by a suitable atomizer nozzle with water conditioned to suit local influences. Thus, if there is a tendency to acidity on contact with oxidizing pyrites, a trace of alkali should be used to give a neutralizing effect. It is significant that under present conditions for every eight tons of ore wound to the surface approximately two tons of water are also carried and if wetting of the stope faces is made more efficient, as described above, this amount of useless wind can be reduced. It may also be practical to instal some form of centrifuge underground for the removal of part of this water before winding.

(*h*) The efficient circulation of ventilating air entering the working stopes should be closely studied by the ventilation officers, since each section will require different methods. Apparatus should be developed for the study of air movement in the variety of shapes of stoped areas to be ventilated. Methods which have been used with great success in aerodynamic research may be adopted for such a purpose, and two of these are mentioned here.

The first is to make a scale model of the section of the stope between two glass plates and induce air movements through this similar to those which might be done in actual conditions, then the path of the air may be studied by introducing small quantities of titanium tetrachloride, which will give a long-defined line in the direction of flow.

The second method is to arrange a model similar to that suggested for the first, but to heat it slightly until all the air entrapped and the surfaces come to a nearly uniform temperature, and set the model at the angle of the stoping reef. Then induce movements of cool air from the presumed inlets, and if the whole model is illuminated from behind by parallel beams of light reflected from a parabolic mirror, the path of the cool air is rendered visible by the fact that the refractive index of air varies with temperature. This latter method brings in the effect of convection currents, but the advantages of both may be combined in one apparatus.

In determining the scale velocities to be adopted, the values of $\frac{v\rho d}{u}$ should be approximately the same for the model and for the full scale stoping area; this number, which is dimensionless, is known as "Reynolds Criterion."

(*i*) The path of the air from the inlet ventilating split to the return airway, where it is considered as vitiated, should be as short as possible under present wet stoping conditions and the writer would suggest to limit this to one or two stoping areas at the most. Foot-wall drives give a convenient method of inlet air control from the main ventilating shaft to the boundary, and on this very important point the writer hopes some discussion by competent men may be forthcoming, since ideal layouts from a ventilation point of view may not be an economic success in mining.

(*j*) The use of portable air conditioning sets placed at suitable positions where, as determined by experiment, they will give increased cooling to the men during drilling and shovelling in the stoping areas. These sets would be air driven and use ice as a cooling agent, which is possibly quite an inexpensive method. Also they can be taken near to the point of useful cooling, so that the effects are not nullified by travelling long distances, and, incidentally, they are easily removable during blasting. These remarks also apply to development ends, and the inlet air to the conditioner may be taken by ducting from the fresh air shaft, so that the vitiated air is not recirculated. It is realized, however, that the exhaust from the rock drills is always helping ventilation under such conditions, but the indiscriminate expansion of compressed air without doing work into badly ventilated areas has been shown to be an expensive method of ventilation.

(*k*) Dehumidifier sets offer some scope for local ventilation improvement with economy, but suffer from the necessity of following up with cooling water pipes.

(*l*) The method of taking air from the surface through large diameter piping, so that it is prevented from picking up moisture, appears to be the best scheme so far considered and is particularly suited to take advantage of the free gift of Nature in the dryness of the air generally available in the district of the Rand. There is no doubt of the benefits to be derived from the supply of large quantities of clean, pure air, free from dangerous dust, at the working levels, and when this can be done at a fraction of the cost of other methods, producing at the best contaminated air slightly cooled, it is worthy of most serious consideration.

The difficulties are mainly of a practical nature in finding accommodation for and installing such a pipe, which need not be circular, but if it is the only way to keep proper working conditions at depth, and when the results can be guaranteed to be of a positive nature on a sufficiently large scale, then there is no doubt that these difficulties will eventually be surmounted.

It may also be possible to improve the results on such a scheme by further removal of moisture on the surface by some hygroscopic substance, such as Silica Gel. The effect of this would be to further depress the wet bulb temperature all through the pipe, thus increasing the cooling effect of the air entering the working areas. This would be particularly advantageous during moist summer conditions. A refrigerating form of dehumidifier would not be efficient for such a purpose, and the heating of the Silica Gel due to trapping of the moisture, would not be detrimental in this instance. It remains to be seen if such a process is economically possible, and the latest results on the applications of Silica Gel to industry, as embodied in the paper of Professor Lees, of Birmingham University, to the present British Association Congress in York, should provide useful data on this question.

(*m*) With the schemes referred to above, it is suggested that drier methods of mining be adopted and during experimental changes, which would normally endanger the health of the workers in the areas under review, the use of respirators might be instituted for protection. The possibilities of giving better air to breathe with the respirator than without it is put forward as a compensating feature against the discomfort and trouble of wearing such a protective device. Also the slight cooling effect used in the respirator may be utilized to assist in clearing the air breathed of dust.

The main factors creating dust could then be studied and any useless methods for dust allaying, which would be shown up by dust sampling with konimeter, etc., would be cut out. Also it appears as if electrostatic methods may be introduced for dust collection, though considerable research will be required before anything final is attained, but it is encouraging that these methods have already been applied to various industries with moderate success.

(VI) Conclusion.—The writer has endeavoured to follow out the troubles now being experienced with ventilation in deep level mining, and to analyse the various suggested methods for improvement, which have practically all been put forward at various times by people in direct touch with the difficulties. It is hoped, therefore, that the rather brief analysis of these methods and the conclusions arrived at may help to crystallize some of the ideas now under discussion. The summary in Table I will give a clear picture of the relative costs involved in the various schemes.

In the light of present knowledge of the situation, it is felt that a mining depth of about 8,300 ft. below Rand datum is just possible with existing wet stoping conditions, but that risks of heat stroke can only be prevented by the free use of the available compressed air, which is an expensive method of ventilation, and cannot be

Table I

	Capital Cost	*Power and Running Expenses per annum*	*Cooling BTU per minute*	*Cost per cooling BTU* $\times 10^5 d$ (15 *Y'rs capital amortn.*).
1. Conservation of evaporative cooling	£75,000	£5,000	354,000	1·3
2. Dehumidifier sets	3,000	820	6,380	7·1
3. Ammonia refrigerating set	120,000	10,000	106,000	8·2
4. Cooling by ice	—	—	—	15·0
5. Compressed air doing work	—	—	—	22·0
6. Compressed air expanded in nozzles	—	—	—	93·0

carried too far. Thus, practical economics will determine for any particular mine the depth at which the existing system ceases to show a profit in working. The temperatures existing in a wet stope at this depth are such that after 16 hours' cooling (time between blasting and entry of men into stopes) the rock surface temperature is depressed by approximately 5° maximum. This contributes to dangerous scaling and rockbursts and, therefore, accidents may be more frequent.

With drier methods of mining, however, and an efficient circulation of relatively dry inlet air, there are possibilities of extending the horizon to at least 11,300 ft. below datum, provided the present geothermic gradient is maintained. The estimated air and rock temperatures are such that it is deduced that cooling conditions of eight wet kata are rendered feasible at these depths with the author's air pipe scheme. The rock surface temperature is only depressed by approximately 1·5° after 16 hours' cooling, with a much greater temperature difference between air and rock than exists with wet stopes at 8,300 ft. These rock surface temperatures are relative values, but it is hoped to estimate absolute values with the aid of new differential equation solutions which have just been published.

There are, of course, quite serious difficulties to be overcome in the application of the methods suggested, but with the probability of ore values being maintained at depth, it may prove well worth while to go on. The problem which requires first attention is the reduction of moisture in the stoping areas with an accompanying decrease in the incidence of phthisis. After that should follow the introduction of drier air at the lowest temperature possible, since it will be realized that the entry of relatively dry air into the present wet stopes may lead to a marked increase in the frequency of rock falls. In this connexion it would be very interesting and instructive during changes in mining methods if an analysis were prepared of the accidents due to rockbursts at various levels. This could be done for each mine at certain pre-determined ranges of level, say, every 500 ft., from 5,000 ft. downwards, and the following system, recently devised by the United States Bureau of Mines, of giving the results was adopted, then the conditions from level to level in different mines would be on a comparative basis and could also be related to figures of accident rates in the mines of other countries where different mining methods are in use:—

A frequency rate is obtained by dividing the number of accidents by the number of million man-hours worked, and a severity rate by dividing the number of days lost by the number of thousands of man-hours worked. To compare the relative hazard based on the combined frequency and severity rates, a common denominator is obtained by adding the products of the frequency and severity rates for each mine; then, by dividing the frequency—severity product for each type by this common denominator, quotients or index numbers are obtained for any class of accident.

It is of interest to note that "controlled" wetting of the dry stope faces under otherwise dry conditions may provide a powerful method of splitting off rock; this, in fact, is how the Ancients used to break up stone. With the pipe scheme suggested for 200,000 cu. ft. per minute of dry air, the power available for such a purpose is 10,000 h.p. at 8,000 ft. level and 12,000 h.p. at 11,000 ft. level. The phthisis danger is intimately connected with the amount of dust raised in handling and conveying the ore, as well as during drilling, and it is hoped that methods will be exploited which will give improvements here.

The very large change in air pressure from Rand-level to about 6,000 ft. below sea-level also presents a problem, and if mines are driven to such depths, then it appears that the men working in the low levels may require to live underground at sea-level probably for periods extending from a week to a month. Living quarters could be perfectly air-conditioned under these circumstances and the men would not be subjected to great extremes of temperature.

Thus the difficulties require very careful study from many points of view, but it is felt that the mining engineers on the Rand have ever been a progressive group and when changes in method are suggested and can be proved beneficial, there is no doubt of them tackling the job in an expeditious manner.

LEAD BULLION REFINING AT BROKEN HILL

Extracts from a paper read by G. K. Williams before the Broken Hill meeting of the Australasian Institute of Mining and Metallurgy are given in the *Chemical Engineering and Mining Review* of Melbourne for October 5 and reproduced here. The author states that in the new refinery of the Broken Hill Associated Smelters at Port Pirie, South Australia, the refining routine is similar to that carried out in the old one in that lead bullion is progressively refined, first for arsenic and antimony, then for copper and gold, then for silver and, finally, for zinc. However, actual procedure differs in that each refining operation is now conducted continuously, whereas in the old refinery intermittent batch treatment was practised.

The early experimental work was concerned solely with the development of the continuous desilverizing process, which, in addition to continuous treatment, embraces the novel feature of conjugate solution formation with consequent production of a silver product relatively high in silver and low in lead. This process would lose some of its attractiveness were it placed between two batch processes; consequently, investigations were made and carried to a successful conclusion in establishing continuous processes for refining for arsenic and antimony and for zinc. It was decided early in 1931 as a result of this work to proceed with the erection of a new refinery embodying the features of the continuous process. This refinery handles the full out-turn of smelter bullion, completely replacing the older process.

Batch Refining Practice.—Previously the refinery consisted of eight refining sets, each set comprising one antimony softening furnace, two desilverizing kettles, one zinc refining furnace, and one market lead pan. The bullion received at the refinery had been previously drossed for copper in the copper-drossing plant, located in the blast-furnace department. The drossed smelter bullion was transported to the refinery in the liquid state, and was delivered first to the antimony softening

furnace, in which the normal scorification was applied, the time allowed for the treatment being 12 hours.

The softened bullion was then tapped into one of the two desilverizing kettles and two zincings were given for the removal of gold. The first gold zincing crusts were pressed and further treated for the recovery of their gold content, whereas the second gold zincing crusts were skimmed and returned to the first gold zincing of the next charge. A quantity of zinc, equivalent to 9 lb. per 2,240 lb. of bullion, was added to each second gold zincing.

After the removal of the gold two additional zincings were given for the removal of the silver. The first silver zincing crusts were pressed and further treated for the recovery of their silver content, whereas the second silver zincing crusts were skimmed and returned to the first silver zincing of the next charge. Virgin zinc was added only to each second silver zincing.

The time required for degolding and desilverizing was 24 hours; consequently, in order to allow the softening furnace to be operated on a 12-hour time-table, two desilverizing kettles were required for each set. When desilverization was completed, the desilverized lead was transferred to the zinc refining furnace in which the normal scorification process was applied. The time allowed for this treatment was also 12 hours. The maximum capacity from each set was two charges of market lead every 24 hours. Of the eight sets in the refinery, five were so-called small sets producing 62 long tons of market lead per 24 hours, and three were larger sets, producing 92 long tons of market lead per 24 hours.

New Refinery.—The new refinery consists of six sections, namely, (*a*) bullion storage section, (*b*) softening section, (*c*) degolding section, (*d*) desilverizing section, (*e*) zinc refining section, and (*f*) moulding section. Its main features are:—(*a*) The bullion storage, softening and degolding sections are direct-coupled. (*b*) The desilverizing, zinc refining and moulding sections are direct-coupled. (*c*) The kettles of the degolding and desilverizing sections are on the one line and are set on foundations that are on the same level. Both these sections are covered by the one building and are commanded by an overhead crane. (*d*) The softening and zinc refining sections are on the same level, and with the moulding section are covered by the one building.

Bullion Storage Section.—This section consists of the following units:—(1) Two bullion storage kettles, each of which is covered with a brick hood to minimize heat loss. This hood is provided with a central hole through which a pump is placed. (2) One 5-ton kettle. The drossed smelter bullion is conveyed in 15-ton ladles from the copper drossing plant to the refinery, where it is pumped into one of the bullion storage kettles. When the pump is not in use it is immersed in a lead bath contained in the 5-ton kettle to prevent cooling. The storage kettle is skimmed once each shift and the dross is delivered to the softening furnace.

The bullion is pumped continuously from the storage kettle into a launder, which discharges into the softening furnace. The bullion storage kettle pump is provided with a valve in its delivery pipe by means of which the rate at which the bullion is continuously pumped from the storage kettle can be readily controlled. The storage kettle is provided with a float gauge, which enables the rate at which the bullion is being pumped from the kettle to be quickly and conveniently derived.

The typical analysis of drossed smelter bullion is:—Copper, 0·068%; arsenic, 0·182%; antimony, 0·410%; silver, 47·2 oz. per ton; gold, 0·10 oz. per ton.

Softening Section.—This section consists of the following units:—(1) Two softening furnaces of the reverberatory type, water-jacketed, 50 ft. long by 11 ft. wide (inside measurements), and each heated by means of two oil burners. (2) Two antimony dross furnaces. (3) Two hard lead 5-ton kettles.

The drossed smelter bullion flows into the softening furnace at one end and softened bullion overflows from the other end through one of two overflow notches, the second notch being provided as a stand-by. During the passage of the bullion through the furnace it is subjected to two conditions:—(1) The heat from two oil burners. Both burners are situated along one side of the furnace, one being near the bullion inlet end and the other in the centre. The flue off-take is at the bullion discharge end of the furnace. These burners are controlled to maintain the temperature of the softened bullion flowing from the furnace within a narrow range around 750° C. (2) The oxidizing influences of the furnace gases. The oxygen tenor of these gases is controlled to be 6 to 8% by suitably adjusting the furnace damper.

The result of the heating and oxidation of the bullion is that the arsenic and antimony contents of the bullion are lowered and the arsenic and antimony, which have been oxidized, enter the liquid antimony dross, which tends to accumulate on the surface of the bullion, but which is made to flow over the bullion counter-current to the flow of the bullion in the furnace. This counter-current flow of antimony dross and bullion is obtained by removing the antimony dross as continuously as possible through an overflow notch situated at the same end of the furnace as the drossed smelter bullion enters.

The antimony dross is delivered through a water-jacketed launder to the continuous antimony dross furnace. The dross enters one end of the furnace and gradually passes through the furnace to the other end, where it is discharged through a slag overflow notch. During its passage through the furnace the dross is subjected to heat and also comes in contact with fine coal, which is added to the furnace in definite quantities every 15 minutes. Thus, as the dross passes through the furnace, it is enriched both in arsenic and antimony, with the result that a relatively high-grade antimony-slag is produced.

The hard lead reduced from the dross, during the treatment in the continuous antimony dross furnace, overflows continuously from the furnace into a 5-ton kettle, from which it is intermittently pumped and delivered to the softening furnace.

The typical analyses of the products of this section are:—

Softened bullion—copper, 0·07%; arsenic, less than 0·0005%; antimony, 0·003%; silver, 47·70 oz. per ton; gold, 0·10 oz. per ton.

Antimony slag—arsenic, 8·6%; antimony, 20·0%; lead, 56·3%; silver, 0·3 oz. per ton.

Weight of antimony slag = 37·5 lb. per ton of market lead.

Degolding Section.—This section consists of the following units:—(1) Two temperature control furnaces. (2) Two gold kettles: each kettle holds 170 tons and is made up of three independent castings, which from top to bottom are (*a*) the top casting, (*b*) the cone casting, and (*c*) the bottom

casting. The brickwork setting is divided into seven super-imposed chambers by means of brickwork arches. Five of these chambers are provided with two burners to each chamber; No. 1 chamber is around the top casting; No. 2 around the cone casting; Nos. 3, 4, and 5 around the bottom casting, and the remaining two chambers surround the two joins and are not provided with oil burners. In chambers 1 to 5 checker walls exist on each side of the kettle parallel with the line of projection of the oil burners, and the combustion of the oil takes place on the further side of these checker walls away from the kettle. The products of combustion pass through the openings in these walls, around the kettle, and thence to the flue. The top casting is provided with three projections. The two projections diametrically opposite are launders, one of which delivers into the kettle-softened bullion and the other liquated gold bullion from the liquating furnace. The remaining projection is a launder for receiving the syphon pipe, which is held in position by plates welded to the casting. The launder, with the syphon pipe in position, is packed with chamotte to prevent leakage of lead. (3) Two liquating furnaces. (4) Two storage kettles, each of which is covered with a brick hood to minimize heat loss. A pump is placed in a central hole in each hood.

The softened bullion overflowing from the softening furnaces gravitates to, and through, the temperature control furnace and thence to the gold kettle. The function of the temperature control furnace is to maintain the temperature of the bullion as it enters the gold kettle at 620° C. Zinc at the rate of 8 lb. per ton of bullion is added regularly every 10 minutes to the softened bullion as it enters the gold kettle.

During the passage of the bullion through the top casting it comes in contact with (*a*) the zinc added, and (*b*) the crusts liberated from the bullion in the lower cooling sections of the kettle; and, as the average temperature in the top casting is 500° C. (no heating is applied around the top casting) the bullion attains a composition corresponding to 500° C. (demarcation temperature). As the bullion is displaced down the kettle, its temperature is gradually decreased until approximately the eutectic temperature is attained at the point of entry of the bullion into the syphon pipe. The cooling of the bullion in the lower sections of the kettle is controlled by a regulation of the quantity of cooling air driven through chambers, 2, 3, and 4.

For efficient operation of the gold kettle, a frozen lead layer should exist at the bottom of the kettle. When this layer increases to such an extent that the bottom of the syphon pipe is likely to become sealed, a light firing in chamber 5 is applied until normal conditions are again obtained.

The crusts, which are liberated from the bullion during its cooling to the eutectic temperature, rise into the top casting, where portion is dissolved in the incoming bullion. The remaining portion accumulates on the bullion surface in the top casting and is periodically removed by skimming every four hours. These gold crusts are skimmed into the liquating furnace, where they are heated to a temperature of 700° C. At this temperature a liquation of bullion from the crusts takes place, with the result that two products are obtained:—(*a*) A liquated gold dross, which is skimmed from the furnace every eight hours. For two weeks out of every three this product is returned to the blast furnaces. The third week it is withdrawn from incirculation and treated for the recovery of its gold content. (*b*) A liquated gold bullion, which is tapped every four hours direct back into the gold kettle. The degolded bullion is discharged continuously from the gold kettle through a launder into the storage kettle, from which it is pumped periodically in 20-ton batches to the desilverizing section.

Typical analyses of the products of this section are:—

Degolded bullion—copper, 0·0098%; zinc, 0·16%; silver, 45·70 oz. per ton; gold, 0·35 grn. per ton.

Liquated gold dross treated for recovery of its gold content—copper, 10·0%; zinc, 32·0%; silver, 350 oz. per ton; gold, 15 oz. per ton.

The weight of liquated gold dross treated for recovery of its gold content is 4·7 lb. per ton of market lead.

Desilverizing Section.—This section consists of the following units:—(1) Three storage kettles, each of which is covered with a brick hood to minimize heat loss and each hood has a central hole through which a pump is placed. (2) Four preheating furnaces. (3) Three silver kettles, each of which holds 360 tons and is made up of four independent castings—(*a*) top casting, (*b*) cone casting, (*c*) straight-sided casting, and (*d*) bottom casting. The brickwork setting of the kettle is divided into nine superimposed chambers by means of brickwork arches; six of these chambers are each equipped with two oil burners. No. 1 chamber is around the top casting; No. 2 around the cone casting; No. 3 around the straight-sided casting, and Nos. 4, 5, and 6 around the bottom casting. The remaining three chambers surround the three joins, and are not equipped with oil burners. In chambers 1 to 6 checker walls exist on each side of the kettle parallel with the line of projection of the oil burners, and the combustion of the oil must take place on the further side of these checker walls, away from the kettle. The products of combustion pass through the openings in the checker walls, around the kettles, and thence to the flue. The top casting is provided with two projections; one is connected with the launder delivering the bullion to the kettle, and provides a submerged inflow into the kettle for the bullion; the other is a launder for receiving the syphon pipe, which is held in position by plates welded to the top casting. When the syphon pipe is securely held in position the launder is packed with chamotte to prevent any leakage of alloy or lead from the kettle.

The bullion, pumped from the gold section in 20-ton batches, is received in one of the storage kettles. It is pumped continuously from this kettle into a launder, which discharges into the preheating surface; the rate of delivery is controlled by a valve in the delivery pipe of the pump and can be quickly derived from the float gauge provided in the storage kettle. The degolded bullion flows through the preheating furnace and thence to the desilverizing kettle. The function of the preheating furnace is to maintain the temperature of the bullion as it enters the silver kettle at 700° C. The top casting of the silver kettle is nearly completely filled with zinc-silver alloy, which, on account of its lower specific gravity as compared with lead, exists on top of the bullion in the kettle.

The degolded bullion on entering the kettle comes in contact with this zinc-silver alloy and also

with the crusts liberated from the bullion in the lower cooling sections of the kettle. Consequently an equilibrium tends to become established whereby conjugate solutions exist; that is, the bullion tends to attain the compositions of the bottom solution, which is in equilibrium with the top solution or zinc-silver alloy existing in the kettle. As the bullion is displaced down the kettle its temperature is gradually decreased until approximately the eutectic temperature is attained at the point of entry of the bullion into the syphon pipe. The cooling of the bullion in the lower sections of the kettle is controlled by a regulation of the quantity of cooling air drawn through chambers 2, 3, 4, and 5.

For efficient operation, the cooling is controlled so that a layer of frozen lead exists in the bottom of the kettle below the syphon pipe. The thickness of this layer is measured by an iron rod placed in the syphon pipe and is closely watched, and, when the clearance between it and the syphon pipe decreases to 4 in., heat is applied to chamber 6 until the clearance is increased to 7 in.; when this application of heat is discontinued and the frozen lead layer again allowed to grow. This application of heat to the bottom of the kettle can be carried out with little effect on the silver content of the desilverized lead.

If the cooling around chambers 2, 3, 4, and 5 has not been sufficient, the clearance between the frozen lead layer and the bottom of the syphon pipe increases without any application of heat in chamber 6, and the kettle runs "hot." In this case, which in practice seldom occurs, the analyses of the hourly samples of desilverized lead are clearly watched, and if the silver content begins to increase unduly, the flow of bullion through the kettle is stopped for a period to allow the kettle to cool back to its normal operating conditions.

The crusts which are liberated from the bullion during its cooling to the eutectic temperature, rise into the top casting, where a portion is dissolved in the incoming bullion. The remaining portion melts and passes into the zinc-silver alloy. Thus, as the treatment of the degolded bullion proceeds, the silver content of the silver-zinc alloy gradually increases until it reaches the value of 7,000 oz. per ton. The alloy is then removed from the kettle, and zinc is added until the thickness of the low-grade silver alloy layer thereby formed is 2 ft. 10 in. Heat is constantly applied around the top casting, both burners in chamber 1 operating at 3·5 gal. per hour.

When the thickness of 2 ft. 10 in. for the alloy layer is obtained, the addition of zinc is discontinued, with the result that the temperature of the alloy gradually increases from 530° C. to 600° C.; at the same time the silver content of the alloy gradually increases to 7,000 oz. per ton, and it is removed from the kettle. During the removal of alloy from, and the addition of zinc to, the kettle, the continuous treatment of bullion through the kettle is maintained. Under Port Pirie conditions, removal of alloy from the kettle occurs approximately once every 24 hours.

Typical analyses of the products of this section are:—

Desilverized lead—copper, 0·0004%; antimony, 0·0280%; zinc, 0·5600%; silver, 0·0300 oz. per ton.

Silver alloy—lead, 15·0%; copper, 0·5%; zinc, 64·0%; silver, 6,000 oz. per ton.

Weight of silver alloy = 18·2 lb. per ton of market lead.

Retort bullion—lead, 39·00%; copper, 1·40%; arsenic, 0·01%; antimony, 0·01%; zinc, 6·60%; silver, 17·000 oz. per ton; gold, 0·26 oz. per ton.

The allocation of the zinc lost in degolding and desilverizing is as follows, the values being given in lb. per long ton of market lead:—

(1)	Refining for gold—		
	Zinc lost in liquated gold dross	4·5	
	Zinc lost in reheating degolded bullion to requisite temperature for silver kettle	1·2	
			5·7
(2)	Refining for silver—		
	Zinc lost in desilverized lead	13·00	
	Zinc lost in retorting silver alloy—		
	(1) In retort bullion	0·35	
	(2) In retort dross	0·31	
	(3) In blue powder	0·91	
	(4) Unaccounted for	0·29	
	Zinc lost when necessity arises to change over from one kettle to another	0·50	
			15·36
	Total		21·06

Zinc Refining Section.—This section will consist of two zinc refining furnaces. At present only one furnace has been constructed. This furnace is in operation, but is still in the developmental stages, especially as regards its size.

The desilverized lead from the silver kettle gravitates through a launder to the zinc refining furnace. The lead flows into the furnace at one end and refined lead overflows from the other end through one of two overflow notches, the second notch being provided as a stand-by.

During the passage of the lead through the furnace it is subjected to the following:—(1) The heat from two oil burners. Both these burners are situated along the side of the furnace, one being near the lead inlet end and the other in the centre. The flue off-take is at the lead discharge end of the furnace. These burners are controlled to maintain the temperature of the refined lead flowing from the furnace within a narrow range around 750° C. (2) The oxidizing influences of the furnace gases. The oxidizing influences are accelerated by means of two submerged air jets which are situated in that portion of the furnace nearest the overflow end.

The result of the heating and oxidation of the lead is that the zinc and last traces of impurities, such as antimony, are removed and appear in the form of a dross which tends to accumulate on the surface of the lead. Accumulation of the dross is prevented by periodic removal of it from the furnace by skimming.

Typical analyses of the products of this section are:—Refined lead—Copper, 0·0003%; bismuth, 0·001%; cadmium, 0·0001%; tin, nil; antimony, 0·0017%; iron, 0·0004%; zinc, 0·00023%; sulphur, 0·0003%; lead, 99·99571%; silver, 0·0001%.

Refiner dross—zinc, 11·0%; antimony, 0·5%.

The area covered by the new refinery is only 48% of that covered by the old. The old refinery with all sets in operation could produce 560 tons of market lead per day. The new refinery with one furnace of each section in operation can produce 560 tons of market lead per day; this value is increased to 1,000 tons per day when an additional silver kettle only is placed in commission.

SWAYZE GOLD AREA, SUDBURY DISTRICT, ONTARIO

A preliminary report on the westward extension of the Swayze township gold area, Sudbury district, Ontario, by H. C. Rickaby, has been published by the Provincial Department of Mines. The author recalls that in August, 1931, a promising discovery of gold was made in the township of Swayze and, as a result of this discovery, during the winter of 1931–32 and the past summer season considerable prospecting activity has taken place in Swayze township and the townships adjoining on the west and north, and a number of other gold discoveries have been made. Favourable developments at the Kenty property, combined with these new discoveries, have enhanced the possible importance of the area, and a number of prospectors and prospecting syndicates are at present working in the area.

The Swayze gold area lies at the west end of a belt of Keewatin greenstones and sediments, previously known to extend from Chester township in the east, westward a distance of approximately 50 miles. Halcrow township, which lies at the west end of the Swayze township area, was found to be underlain by greenstones and sediments and apparently represents the western limit of the belt. The south part of the township shows a band of sediments which are regarded as the westward extension of the Ridout Series of Greenlaw and Cunningham townships to the south-east. North of the Ridout sediments is a band of greenstone consisting chiefly of basaltic lava flows. Another band of sediments and tuff approximately 1½ miles wide extends across the north part of the township and may be followed eastward across the townships of Denyes and Swayze. This band of sediments appears to form the uppermost series of the older rocks of the area. All three of these bands are cut off along the west and north-west by gneiss and granite. The intrusive rocks at Halcrow township consist of dykes of porphyry, granite, and diorite, presumably Algoman in age, and diabase. Regional schistosity is very marked, particularly in the south half of Halcrow township, the schisted bands striking approximately east and west. Kinagama River flows north across the townships of Tooms and Halcrow, and forms the best canoe route into Halcrow township. The route starts from mileage 107 on the Canadian Pacific Railway and requires but one portage of 27 chains between the railway and the south boundary of Halcrow.

An examination has been made of the north band of sediments of Halcrow township, which extends eastward across the north parts of Denyes and Swayze townships into Dore township. This band, known as the Swayze Series, consists of sediments including conglomerate, arkose, greywacke, and quartzite, interbedded with tuffs and acid pyroclastics, and has an average width across the three townships of approximately two miles. Study of the bedding and cleavage relationships indicates that the Swayze Series is in the form of a syncline with its axis striking approximately E.–W., and with its axial plane dipping to the north. It appears to form the uppermost series of the greenstone sedimentary complex. Throughout its length it is intruded by numerous dykes of grey and red felspar and quartz porphyry and lamprophyre, most of these dykes having an E.–W. strike. Besides the true porphyry intrusives there are wide zones of sediments and volcanics of the Swayze Series which have been much altered, presumably by contact metamorphism, so as to give them a marked porphyritic appearance. In many instances it was difficult to draw definite lines between the true porphyry and these altered clastic rocks. The intrusive porphyry dykes are not confined to the sedimentary band, but also intrude the basic lavas along both limbs of the syncline. The essential features of all the discoveries appeared to be favourable structures in the form of fractures or shear zones in either lavas or sediments combined with the proximity of porphyry or granite intrusions.

The following is a short description of the most important discoveries in the area :—

Swayze Township :

Kenty Gold Mines, Ltd.—This property has received vigorous and efficient development by a small crew of men since its discovery in August, 1931. The work consisted entirely of surface trenching and test pitting combined with a geological study of the rocks and rock structures with which the veins are associated. A large number of veins have been uncovered, most of which carry appreciable values in gold and in some of which the showings of native gold are spectacular. Most of the veins strike from N. 40°E. to N. 70°E., and dip to the south at angles varying from 40° to 75°. They occur largely in Keewatin basaltic lavas and tuffs or in basic rocks and porphyry or lamprophyre dykes, which are intrusive into the Keewatin rocks. A large body of porphyry lies along the south part of the property, but none of the veins have, as yet, been traced into it. Two systems of post-mineral faults intersect the veins, one system striking approximately N. 15°W., and another system E. 15°S. The work up to date seems to indicate five main parallel vein systems with smaller subsidiary veins between them. One vein, consisting of several faulted portions, has been traced for a distance of 1,500 ft., striking N. 60°E., with possible extensions in both directions. A section of this vein, 90 ft. in length, has some very spectacular native gold showings. The maximum width of vein material in the veins disclosed up to date is 10 ft. All the veins are of the same general type and consist of fractures along which quartz has been deposited as veins or a series of parallel stringers. The quartz and wall rocks are heavily mineralized with pyrite and ankerite. Tourmaline is prominent in the quartz, while other minerals noted were calcite, galena, specularite, graphite, chalcopyrite, and native gold.

A number of small veins similar to those on the Kenty property have been uncovered on the claims of the McNeeley-McCullough, Montgomery, and Miner Kenty properties lying to the west, south, and east respectively of the Kenty mines. These three properties are being further prospected in view of the success which has attended the work on the Kenty Gold Mines, Ltd.

Denyes Township :

Dyment Mining and Investments, Ltd.—This property, comprising a group of 31 claims, lies along the north side of Dyment Lake in Denyes township. The group of claims, which is about two and a quarter miles long, in an E.–W. direction, by three-quarters of a mile wide, lies along the contact between the Swayze Series to the north and the Keewatin greenstones to the south.

A number of porphyry dykes intrude the country rock along the contact and one large mass of porphyry occurs at the south-west end of Dyment Lake. The showings, which occur near the large porphyry mass at the south-west end of the lake, consist of quartz lenses in a band of schist up to 300 ft. wide, striking E. 10°S. The original nature of the schistose rock is difficult to determine—in places it looks like schistose porphyry, but is probably an altered arkose or tuff. The quartz lenses are fairly continuous for a length of 175 ft., and smaller lenses and stringers may be seen for a distance of 600 ft. to the west. These lenses cut across the strike of the schist at small angles. One trench shows two lenses of quartz each about two feet wide with 14 ft. of schist between. The schist has been considerably carbonated and mineralized with pyrite. The quartz is milky white in colour and well fractured, and fine native gold is visible along the fractures. Galena, specularite, and a little chalcopyrite were also noted in the vein. A narrow diabase dyke parallels the vein and quartz lenses to the west, cutting across it in one place. The work up to date consists of shallow trenching and test pits. Some surface work has been done on the claims at the east end of the lake, where a similar band of schist occurs and some gold values are reported. It is the intention of the management to carry on with surface work with a small crew for some time.

Derraugh Claims.—This property lies near the east boundary of Denyes township near the 4 mile post. The country rock consists of altered sediments cut by dykes of felspar porphyry. The showing is in claim No. S.22459, about 11 chains south of the No. 1 post and 300 ft. from the east boundary. It consists of quartz lenses along a fracture which strikes approximately north and south and dips steeply to the east. The fracture had been traced by stripping for a length of 175 ft. One lens shows a maximum width of 8 ft. of quartz and parallel stringers of quartz occur in the foot-wall for a few feet. The quartz is heavily mineralized with fine chalcopyrite and pyrite, and shows some carbonates and a little galena. No native gold was seen, but samples of the quartz from the lens on which most work had been done showed good values in gold. This discovery was made in the latter part of the field season and only a small amount of trenching had been done when the property was visited.

Sylvanite Claims. — This property comprises a group of 18 claims in the north-west part of Denyes township. In the south-east corner of claim S. 21131 trenching has uncovered a series of parallel porphyry dykes striking E.–W. intruding a schistose rock, which is probably a tuff. The porphyry and schist has been fractured and the fractures filled with stringers of quartz carrying considerable pyrite. No visible gold was noted, but a chip sample across three feet of mineralized schist and porphyry was reported to assay $4·00 per ton in gold. A grab sample of well-mineralized quartz assayed $7·20 per ton in gold. Trenching and stripping has uncovered the mineralized zone for a length of 400 ft.

Raney Township :

Thorne-Greaves Syndicate.—A large group of claims was staked in the township of Raney. Two quartz veins have been discovered on claim No. S. 22366, about 30 chains north-east of the large bay of Raney Lake. One vein with a width of two feet, where exposed at the east end of the trenching, has been traced for a distance of 200 ft. It strikes E. 10°S. and stands perpendicularly. The quartz is milky white and contains considerable carbonates and fine pyrite with a little visible gold in one place. The country rock of this vein is greywacke or impure quartzite. Five hundred feet to the south-west another narrow quartz vein up to six inches in width and striking N. 60°E. has been traced for a distance of 100 ft. It occurs in felspar porphyry and shows a little visible gold in one place. Other minerals noted in the quartz were chalcopyrite, galena, and tourmaline.

Rollo Township :

Cyril Knight Prospecting Co., Ltd.—A group of 15 claims was staked by Miner Kenty in September on the south side of Ridley Lake, which lies on the west boundary of Rollo township. Near the north-west corner of claim No. S. 22721 of this group a quartz vein was discovered by Mr. Kenty. At the time the property was visited the quartz had been stripped for a length of 70 ft., showing a width of 2½ ft. at the west end and 15 ft. at the east end. The country rocks are basaltic lavas, which have been slightly schisted. The vein strikes N. 51°E. and dips about 70° to the south. The quartz is blueish to glassy, but well fractured, the fractures being parallel to the strike of the vein. Fine pyrite occurs in places in the quartz and wall rock and some fine native gold was visible in two places in the vein. Six hundred feet to the north-east along the strike more quartz has been uncovered. Further work in the shape of trenching and stripping is being done on this showing.

W. H. Graves' Property.—This group of 15 claims lies immediately south of the Cyril Knight Prospecting Company's property described above and extends from the west boundary of Rollo Township eastward to within a quarter of a mile of Rollo Lake. The main showing, on claim S. 22632, consists of a quartz vein from 4 in. to 13 in. wide exposed for a length of 30 ft. It strikes N. 45°E. and dips 50° to the north. It occurs in what is thought to be an arkose or greywacke. The quartz carries moderate quantities of pyrite and carbonates and a little galena. Native gold is reported to occur in this quartz. Stringers of similar quartz which are reported to pan gold freely have been uncovered 12 chains west and 10 chains east of this vein.

Halcrow Township :

Hughes-Shunsby Claims.—This property comprises a group of 36 claims lying in the west part of Halcrow township. Near the No. 1 post of claim S. 22149 of this group a discovery of gold-bearing quartz was made in July of this summer. The quartz occurs as narrow stringers along a fractured zone, which has been mineralized with pyrite and carbonates. It has been traced for a length of 800 ft., striking E. 20°S. The fractures are parallel to a dyke of quartz-diorite from 60 to 100 ft. wide which was followed for a distance of a quarter of a mile and lies about 75 ft. to the north The quartz contains considerable chalcopyrite and fine native gold was visible in one place. The work so far has indicated fair values in gold across narrow widths. Two channel samples across 26 in. and 34 in. in the main pit are reported to have assayed $7·80 and $10·46 per ton in gold respectively.

Greenlaw Township :

Newbec Claims.—A group of ten claims was staked on the west side of Hotstone Lake. The showing, which occurs near the centre of claim No. S. 22711,

consists of a quartz vein 2 ft. wide uncovered for a length of 100 ft., striking E. 18°S., and dipping 60° to the north. The vein occurs in a schistose greywacke which is near the south edge of the Ridout Series of sediments. The strike of the vein and some smaller veins in the vicinity appears to be the same as that of the schist. The quartz is glassy to whitish in colour and rusty owing to the oxidation of carbonates, which are present in considerable amounts. Very little sulphide mineralization was noted and no native gold was seen, but grab samples of the quartz from three places showed appreciable values in gold. Considerable greenish micaceous mineral, probably fuchsite, is present in the schist of the wall rocks. Three hundred feet west and 60 ft. east similar quartz in stringers and veins has been uncovered while parallel stringers were noted in the foot wall rocks. Some old pits in the vicinity of the showings described above afforded evidence that the ground had been prospected some years ago.

CONCLUSION.—The gold-bearing quartz veins described above are distributed over a block of six townships and a number of other smaller veins have been discovered in the area. The only significance that may be attached to some of these occurrences is that they may be leads to larger and more important discoveries in the vicinity. Nevertheless, the fact that all these discoveries have been made during the past season, combined with the encouraging results of the development work at the Kenty Gold mines, shows that the Swayze gold area holds out considerable promise from the standpoint of valuable gold deposits.

SHORT NOTICES

Long-Slope Mining.—A variation of the spiral-stope method of mining, called long-slope mining and which is practised at Anyox, B.C., is described by F. S. McNicholas in the *Engineering and Mining Journal* for November.

Caving Costs.—M. J. Elsing in the *Engineering and Mining Journal* for November deals with the cost of mining by caving.

Noranda's New Hoist.—Electrical characteristics of the new Nordberg hoist at Noranda are described by G. W. Arnold in the *Canadian Mining Journal* for November.

Hoist Design.—In the *Engineering and Mining Journal* for November L. Eaton discusses hoist design and construction.

Detachable Drill Bits.—Various types of detachable drill bits are described by A. H. Hubbell in the *Engineering and Mining Journal* for November.

Ore-Treatment at Jackson, California.—H. Jullum describes the ore-treatment employed at the Argonaut mine, Jackson, California, in *Mining and Metallurgy* for November.

Electrolytic Zinc Production.—P. Röntgen and R. Buchkremer discuss the influence of metallic impurities on the production of electrolytic zinc in *Metall und Erz* for November 1.

Copper Embrittlement.—Discussion of a paper by L. L. Wyman on copper embrittlement which was presented at the Autumn meeting of Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers, is published in *Mining and Metallurgy* for November.

Flotation of Non-Metallics.—A short article on the flotation of non-metallic minerals by O. Sommer appears in the *Engineering and Mining Journal* for November.

Coal-Mine Waste for Concrete.—In *Mining and Metallurgy* for November H. H. Hughes discusses the use of coal-mine waste in concrete.

Hadsell Mill.—A description of a new type of ore-crusher, known as the Hadsell mill, is given in the *Canadian Mining and Metallurgical Bulletin* for November.

Rosebery District, Tasmania.—The first part of a preliminary report on the geology of the Rosebery district, Tasmania, by K. J. Finucane, appears in the *Chemical Engineering and Mining Review* of Melbourne for October 5.

Sulphide Ore of Hydrothermal Origin.—A description of the ore-body at the Cowboy mine in Josephine County, Oregon, which is a massive sulphide deposit occurring in serpentine, is given by P. J. Shenon in *Economic Geology* for November.

Andalusite.—In *Economic Geology* for November P. F. Kerr gives a description of the andalusite mine near White Mountain, California, at present the only commercial deposit of importance in the United States.

Gold-Uraninite Association.—P. Kreiger describes an association of gold and uraninite from Chihuahua, Mexico, in *Economic Geology* for November.

Pitchblende from Great Bear Lake.—The characteristics of pitchblende from Great Bear Lake are described by H. S. Spence in the *Canadian Mining Journal* for November.

Gold in Manitoba.—In the *Canadian Mining and Metallurgical Bulletin* for November A. J. McLaren discusses the position of Manitoba as a gold-producing country.

Magnesite in India.—F. Lebeber gives some notes on the occurrence of magnesite in India and on methods used in mining it in the *Iron and Coal Trades Review* for November 4.

Summit Lake-Birch Lake, Ontario.—A preliminary report by G. D. Furse, on the Summit Lake–Birch Lake area, Patricia district, Ontario, has been published by the Department of Mines, Ottawa.

Russian Coalfields.—The first of a series of articles on the Russian coalfields by M. H. Haddock appears in the *Colliery Guardian* for November 11.

South African Mineral Prodution.—In his presidential address before the Chemical Metallurgical, and Mining Society of South Africa, T. Nimmo Dewar dealt with the mineral production and resources of the Union. His address is published in the *Journal* of the Society for September.

Alberta.—In a paper presented before the Calgary Branch of the Engineering Institute of Canada in February last, J. A. Allan dealt with the future mineral development of Alberta.

Jammu and Kashmir.—An article dealing with the mineral resources of Jammu and Kashmir appeared in *Engineering* for November 11.

Roan Antelope.—Mining Practice at the Roan Antelope mine in Northern Rhodesia is described by R. M. Peterson in the *Engineering and Mining Journal* for November.

Argentine Glance Pitch.—An article by A. W. Allen on Argentine glance pitch is published in the *Engineering and Mining Journal* for November.

Boron Determination.—The spectroscopic method of determining boron is described by J. S. McHargue and R. K. Calfee in *Industrial and*

Engineering Chemistry (Analytical Edition) for October 15.

Ionian Islands.—Dr. Arthur Wade publishes a note on the geology of the Ionian Islands in the *Journal* of the Institution of Petroleum Technologists for September.

Reinforced Concrete Poles.—W. T. Taylor discusses reinforced concrete pole design in the *Engineer* for October 28.

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.*

19,476 of 1931 (381,955). American Smelting and Refining Co., New York. Tin is removed from a bath of molten antimonial lead by rapid agitation to form a dross, which is stirred back into the bath, the dross being removed periodically until the desired composition is reached.

20,007 of 1931 (381,931). Mond Nickel Co., Ltd., and R. H. Atkinson, London. The deposition of palladium from a solution in ammonia of palladosammine chloride is improved by the use of a diaphragm cell with a catholyte consisting of a solution in ammonia of a palladium-ammino compound and an anolyte containing ammonia.

20,008 of 1931 (381,932). Mond Nickel Co., Ltd., and A. R. Raper, London. The palladium content of baths for plating purposes is maintained by the use of a pure palladium anode in a bath capable of anodically dissolving the palladium, such an electrolyte consisting of a solution of an alkali or alkaline earth metal nitrite of palladium in water in the presence of chlorine or bromine ions.

20,682 of 1931 (380,884). Berzelius Metallhütten G.m.b.H., Duisburg-Wanheim, Germany. Tin, lead, antimony, or bismuth, or alloys of these metals, are recovered from materials containing these metals as oxides, and which may contain in addition zinc oxide, by working up in a zinc reduction furnace in the presence of protective and fluxing agents such as water-glass, borax, or sodium carbonate.

23,928 of 1931 (382,014). A. Sprenger, Berlin. High-grade refractories highly-resistant to acid slags are prepared by a smelting process from oxides of chromium, aluminium, and magnesium.

26,042 of 1931 (381,695). F. G. L. Scott, London. Apparatus for geophysical surveying which makes use of the application of d.c. currents to the area to be surveyed.

34,416 of 1931 (381,776). Fried. Krupp Grusonwerk A.-G., Magdeburg-Buckau, Germany. Apparatus for the treatment of ores by flotation processes in which a combination of agitating and aerating means are used for thorough treatment of the slimes.

2,127 of 1932 (382,146). J. Kemp, Brussels. Zinc solutions containing ferrous iron are treated with powdered alkaline-earth carbonates for the quick conversion of the iron to Fe_3O_4 in a state easily separable from the solutions.

11,804 of 1932 (381,115). Österreichisch Amerikanische Magnesit A.-G., Radenthein, Austria. Metallic magnesium is produced from magnesium oxide in a reduction chamber maintained at such a temperature that the reaction $MgO + C \rightleftarrows Mg + CO$ is disposed practically from left to right.

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.

Metamorphism : A Study of the Transformations of Rock Masses. By Dr. Alfred Harker. Cloth, octavo, 360 pages, illustrated. Price 17s. 6d. London : Methuen and Co.

The Form and Properties of Crystals : An Introduction to the Study of Minerals and the Use of the Petrological Microscope. By A. B. Dale. Cloth, octavo, 186 pages, illustrated. Price 6s. Cambridge : University Press.

The Metals—Their Alloys, Amalgams, and Compounds. By A. F. Collins. Cloth, octavo, 310 pages, illustrated. Price 7s. 6d. London : D. Appleton and Co.

Man and Metals : A History of Mining in Relation to the Development of Civilization. 2 vols. By Dr. T. A. Rickard. Cloth, octavo, 1,068 pages, illustrated. Price 50s. New York : McGraw Hill.

Die wichtigsten Lagerstätten der Nichterze. Band IV, Phosphat-Nitrat. By Dr. O. Stützer, and Dr. W. Wetzel. Paper covers, 390 pages, illustrated. Price RM. 32. Berlin : Grehüder Borntraeger.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. XII. U, Mu, Ma, Re, Fe (Part I). Cloth, octavo, 944 pages, illustrated. Price 63s. London : Longmans, Green and Co.

Measurement of Oil in Bulk. Part I—Standard Weights and Measures. Cloth, octavo, 30 pages. Price 2s. 6d. London : Institution of Petroleum Technologists.

La Géologie et les Mines de la France d'outre-Mer. Publication du Bureau d'Études Géologiques et Minières Coloniales. Paper covers, 604 pages, illustrated. Paris : Société d'Éditions Géographiques, Maritimes et Coloniales.

Mineral Industry of the British Empire and Foreign Countries. Statistical Summary, 1929–1931. Paper covers, 398 pages. Price 6s. London : H.M. Stationery Office.

Canada : Department of Mines Report to March 31, 1932. Paper covers, 50 pages. Price 25 cents. Ottawa : Department of Mines.

Refractory Clays in Canada. By J. F. McMahon. Canadian Department of Mines Memorandum Series No. 57. 26 pages typescript. Ottawa : Department of Mines.

The Bushveld Igneous Complex of the Central Transvaal. By Dr. A. L. Hall. Union of South Africa Geological Survey Memoir No. 28. Paper covers, 560 pages, illustrated, with maps. Price 10s. Pretoria : Department of Mines and Industries.

The Building Stones of the Union of South Africa. By W. Wybergh. Union of South Africa Geological Survey Memoir No. 29. Paper covers, 244 pages, illustrated, with map. Price 7s. 6d. Pretoria : Department of Mines and Industries.

Heat Transfer from a Gas Stream to a Bed of Broken Solids. By C. C. Furnas. United States Bureau of Mines Bulletin 361. Paper covers, 88 pages, illustrated. Price 10 cents. Washington : Superintendent of Documents.

Clinker Formation—as Related to the Fusibility of Coal Ash. By P. Nicholls and W. A. Selvig. United States Bureau of Mines Bulletin 364. Paper

covers, 71 pages, illustrated. Price 10 cents. Washington: Superintendent of Documents.

Elk Hills, California: Geology and Oil Resources. By W. P. Woodring, P. V. Roundy, and H. R. Farnsworth. United States Geological Survey Bulletin 835. Paper covers, 82 pages, illustrated, with maps. Price 60 cents. Washington: Superintendent of Documents.

Tatonduk-Nation District, Alaska. By J. B. Mertie, Jr. United States Geological Survey Bulletin 836-E. Paper covers, pp. 347–454, illustrated. Price 15 cents. Washington: Superintendent of Documents.

Production of Explosives in the United States, 1931. By W. W. Adams and L. S. Gerry. United States Bureau of Mines Technical Paper 540. Paper covers, 42 pages. Price 5 cents. Washington: Superintendent of Documents.

Investor's Pocket List of Reference Tables, 1933. Paper boards, 12 pages. Price 1s. London: Fredc. C. Mathieson and Sons.

COMPANY REPORTS

Van Ryn Gold Mines Estate.—This company was formed in 1894 and operates a gold mine on the Eastern Rand. The report for the year to June 30 shows that 738,010 tons of ore was sent to the mill, where 172,810 tons was sorted out as waste. A total amount of 566,000 tons was crushed, yielding 123,957 oz. of gold, worth £526,976. Working costs amounted to £468,871 and the working profit to £58,104, sundry revenue bringing this up to £74,724. After making various allowances the profit for the year was £56,408, of which £43,750 was distributed as dividends, equal to 8¾%. The ore reserves at the end of the year were estimated to be 490,491 tons, averaging 4·1 dwt. over 40 inches, as compared with 576,664 tons, averaging 4 dwt. over 42 inches, at the end of the previous year.

Messina (Transvaal) Development.—This company was formed in 1905 and operates copper mines in the Zoutpansberg district of the Transvaal. The report for the year ended June 30 last shows that 368,258 tons of ore, averaging 2·64% copper, was produced, against 313,220 tons, averaging 2·89% copper, in the previous year. The tonnage treated in the mill was 368,147, the production of hand-picked ore and concentrates amounting to 17,503 tons, averaging 53·64% copper. At the smelter 8,177 tons of ingots was produced, the product averaging 99·88% copper. The accounts show a profit of £1,256, which, added to the balance brought in, gave an available total of £54,866. Of this amount £1,610 was placed to reserve, the balance of £53,256 being carried forward. The ore reserves at the end of the year were estimated to be 1,183,422 tons, averaging 2·61% copper, as compared with 1,241,379 tons, averaging 2·75% copper at the end of the previous year.

South West Africa Company.—Formed in 1892 this company operates the Abenab vanadium mine in addition to acting as an investment corporation. The report for the year to June 30 last states that vanadium sales were unable to keep pace with production during the year, so that the Abenab mine has been closed down as from September 1 last. The accounts show a profit of £33,267, to which must be added £5,930 not required for income tax. After adding the sum of £90,324 brought in, deducting £79,771 distributed as dividends and bonuses, equal to 15%, and making other allowances, there was a balance of £48,096 to be carried forward.

Burma Corporation.—Formed in 1919, this company operates a silver, lead, zinc, and copper mine at Bawdwin in the Federated Shan States of Upper Burma. The report for the year to June 30 last shows that the output of refined lead and silver for the year amounted to 70,560 tons and 5,842,789 oz. respectively, as compared with 76,520 tons and 6,512,780 oz. in the previous year. During the year 362,775 tons of ore was extracted, having an average assay value of 22·6 % lead, 11·3% zinc, 1·48% copper, and 20·1 oz. silver per ton, as compared with 462,184 tons, averaging 21·9% lead, 11·4% zinc, 1·62% copper, and 19·5 oz. silver per ton, in the previous year. In addition to the lead and silver produced, 47,196 tons of zinc concentrate, averaging 51·66% zinc, 6·01% lead, and 9·02 oz. silver per ton was shipped to Europe, and 4,197 tons of nickel speiss, 10,349 tons of high-grade copper matte, and 839 tons of antimonial lead recovered from the blast furnaces. The ore reserves at the end of the year were estimated to be 4,127,247 tons, averaging 25·4% lead, 15·6% zinc, 0·68% copper, and 19·7 oz. silver per ton, as compared with 4,233,120 tons, averaging 25·5% lead, 15·3% zinc, 0·76% copper, and 20·1 oz. silver per ton, at the end of the previous year. The net profit for the year amounted to Rs. 28,72,537, to which must be added the sum of Rs. 6,17,629 brought forward from the previous year, making an available total of Rs. 34,90,176. Rs. 16,92,711 was distributed as a dividend, leaving a balance of Rs. 17,97,465 to be carried forward.

Camp Bird.—This company was originally formed in 1900 to work a gold mine in Colorado, but now has other interests in Mexico and in N.S.W. The report for the year to June 30 last shows that the lessees of the Camp Bird mine paid £2,643 in rent and royalties, all of which went towards the costs of maintenance. Operations at the Santa Gertrudis mine are reviewed elsewhere in this issue. At the Lake George mine development of the process for the recovery of sulphur from pyritic concentrates was continued during the year and it is expected that as soon as the investigations are completed the erection of a treatment plant will be possible. The results of the Mexican Corporation are also reviewed elsewhere in this issue. The Durango Timber Co.'s profits showed no improvement during the year, while the interest in the Creole Petroleum Corporation has been disposed of. The company has now acquired interests in the Wiluna Gold Corporation and, through its agreement with New Consolidated Gold Fields, Ltd., interests in various new projects of that company. The accounts for the year show a loss of £40,256, increased, after allowing for debenture interest and depreciation on investments to £114,705. After allowing for the credit balance brought in from the previous account and transferring £5,386 from income tax reserve, there remained a debit balance of £54,941 to be carried forward.

Mexican Corporation.—This company was formed in 1919 and is interested in the Teziutlan copper-zinc property in Puebla and also in the Fresnillo silver mine, Zacatecas, Mexico. The report for the year ended June 30 last shows that at Fresnillo the cyanide mill treated 563,740 dry tons of oxide ore and 206,842 dry tons of Santa Ana tailings, a total of 770,582 tons, averaging

0·217 dwt. gold and 5·72 oz. silver. The bullion recovered contained 5,657 oz. of gold and 2,929,888 oz. of silver. The concentrator treated by selective flotation 197,009 tons of sulphide ore, averaging 0·241 dwt. gold, 9·84 oz. silver, 9·0% lead, 9·7% zinc, and 0·76% copper, producing 28,569 tons of lead concentrates, 26,838 tons of zinc concentrates, 1,320 tons of copper concentrates, and 1,599 tons of pyrite concentrate. The ore reserves at the end of the period under review were estimated to be 2,992,745 tons of oxide ore averaging 0·13 dwt. gold and 4·5 oz. silver, together with 1,203,348 tons of sulphide ore, averaging 0·2 dwt. gold, 10·3 oz. silver, 7·8% lead, 9·0% zinc, and 1·0% copper. At the Teziutlan mine operations were only carried on for six months, the plant being closed down at the end of 1931. During the six months run 31,571 tons of sulphide ore was treated, producing 398 tons of lead concentrates, 4,245 tons of copper concentrates, and 5,644 tons of zinc concentrates. The ore reserves at this mine at the end of the year were estimated to be 129,559 tons, averaging 0·7 dwt. gold, 3·0 oz. silver, 3·0% lead, 3·2% copper, and 17·5% zinc. The accounts of the Mexican Corporation for the period under review show a loss of £8,538, increasing the debit balance brought in to £17,125.

Santa Gertrudis.—This company was formed in 1909 as a subsidiary of Camp Bird, Ltd., to operate a silver mine at Pachuca, Mexico. Work on the Santa Gertrudis property ceased in 1925 and the company now works a group of neighbouring mines. The report for the year to June 30 last shows that during the year the mill of the Cia. Beneficiadora de Pachuca treated 328,450 dry tons of ore having a gross assay value of $2,764,129 U.S. currency, the ore milled coming chiefly from the mines of the Dos Carlos company. The bullion recovered contained 28,726 oz. of gold and 6,390,460 oz. of silver. The ore reserves at the end of the year were estimated to be 229,015 tons, a reduction of 286,814 as compared with the previous year's total. The accounts show a profit of £44,194, which, added to the sum of £35,767 brought in from the previous account gave an available total of £79,961. Of this amount £37,644 has been placed to reserve and £38,835 absorbed in the payment of 6d. per share, leaving a balance of £3,482 to be carried forward. In July last new ore was found in the Elena and Necesidad ground and intensive development in these areas is now in hand.

Frontino Gold.—This company, formed in 1911, works gold mining properties in Colombia. The report for the year to June 30 last shows that 31,990 tons of ore from the Silencio mine was milled, against 29,970 in 1931, the production of 36,134 oz. gold and 25,447 oz. of silver showing increases of 5,495 oz. gold and 4,392 oz. silver over the previous year's totals. From Marmajito 12,190 tons was milled for a yield of 10,440 oz. gold and 7,089 oz. silver. The profit for the year amounted to £78,855, making, after adding sundry receipts and the balance brought in from the previous year, an available total of £91,930. Of this amount debenture interest absorbed £2,692, £2,000 was placed to income tax and £35,000 to ordinary reserve, and £26,881 distributed as dividends and bonuses, leaving a balance of £25,357 to be carried forward. The directors have in view a policy of expansion at the operating mines, as well as the development of other mines on the company's property, and to provide funds for this purpose it is proposed to offer the 36,610 unissued ordinary shares at par to existing shareholders, *pro rata* to their holdings.

Associated Gold Mines of Western Australia.—This company was formed in 1925 and operates a gold mining property on the Coolgardie Goldfield, Western Australia. The report for the year ended March 31 last shows that 61,618 tons of ore was treated during the year, yielding 19.155 oz. gold and 1,189 oz. silver, worth £81,389, while tributers treated 1,212 tons for a return of £6,675, paying £1,797 in royalty. In addition, the company received £15,393 in respect of premium on gold and £26.393 (Australian) as exchange premium, while £2,798 was received as gold bounty on the 1931 production. Operations for the year resulted in a profit of £17,337, increasing the credit balance brought in to £17,496. From this amount a dividend equal to 6d. per share was distributed, leaving a balance of £2,611 to be carried forward. Broken ore lying in the stopes is estimated at 26,393 tons, averaging 24·1s. per ton, being 803 tons and 2·1s. per ton less than at the end of the previous year.

Golden Horse Shoe (New).—This company was formed in 1929 to work over the dumps of the old Golden Horse Shoe mine at Kalgoorlie, Western Australia. The report for the year to September 30 last shows that 413,620 short tons of tailings were retreated, the yield being equivalent to 4s. 7d. per ton, won at a cost of 2s. per ton. The net profit for the year was £28,950, which, added to the balance of £9,161 brought in from the previous account, gave an available total of £38,111 to be carried forward pending an appeal against the company's assessment for income tax. At the end of the period under review a balance of 1,751,524 short tons was estimated to remain in the dumps.

Mount Elliott.—This company was formed in 1907 and owns copper mines in North Queensland, as well as an interest in the South American Copper Co., Ltd. The report for the year to June 30 last shows that tribute ore production at the mines in the Cloncurry district amounted to 6.741 tons, assaying 18·99% copper, which realized £22,102, of which £1.172 accrued to the company in royalties. Subsequent disputes between the tributors and employees resulted in a suspension of activities in October, 1931, which lasted almost throughout the year under review, although operations have now been resumed. The accounts show a loss for the year of £7,245, increasing the debit balance brought in to £56,292.

Trepca Mines.—This company was formed in 1927 and operates a lead-zinc property in Yugoslavia. The report for the year to September 30 last shows that 397,963 tons of ore was sent to the mill, where 48,566 tons of lead concentrates and 62,192 tons of zinc concentrates were produced. The accounts show a net profit of £114,348, which, added to the balance of £20,303 brought in, gave an available total of £134,651. Of this amount £17,478 was absorbed in expenditure on the Breskovo area, while dividends equal to 10% absorbed £110,062, leaving a balance of £7,111 to be carried forward. The installation of the third unit of the treatment plant and the extensions to the power plant were completed and the capacity of the plant is now over 1,400 tons per day.

Kepong Dredging.—Formed in 1923 this company operates alluvial tin property in the State of Selangor, F.M.S. The report for the year ended June 30 last shows that, in view of restriction

imposition, operations during the year have been confined to tribute workings. The loss for the year amounted to £2,716, increasing the debit balance brought in to £4,878.

Consolidated Tin Mines of Burma.—This company was formed in 1928 and operates tin-wolfram properties in the Tavoy district of Burma. The report for the year ended June 30 last shows that 1,329 tons of mixed concentrates was produced, while 7½ tons was purchased locally, a policy of voluntary curtailment of output having been pursued during the year. The accounts show a surplus of revenue over expenditure equal to £4,042, against a loss of £15,737 in the previous year, the debit balance carried forward being reduced to £13,020.

Anglo-Burma Tin.—This company was formed in 1926 and operates alluvial tin properties in the Tavoy and Mergui districts of Lower Burma. The report for the year to June 30 last shows the total output of tin ore from the Heinda and Thabawleik properties to have been 368 tons of a value of £32,752. The working profit was £12,127, against £5,496 in the previous year, the net profit being £2,883, against a loss of £497. After deducting the debit balance brought in and allowing £1,650 for a dividend of 5%, there remained a balance of £579 to be carried forward. A new pipe-line, 9,500 ft. long, was completed during the year, since which the whole plant has worked very efficiently.

Weardale Lead.—This company has worked lead mines in Weardale, County Durham, since 1883. The report for the year ended September 30 last shows that during the period there was no output from the mines, operations having been restricted to maintenance measures, the small demands for lead ore and fluor spar being met from stock. The accounts for the year show a loss of £2,560, reduced, after allowing for income from investments, to £1,540, which increases the debit balance brought in to £10,002.

British Burmah Petroleum.—This company was formed in 1910 and operates on the Yenangyaung and Singu oilfields in Burma. The report for the year to July 31 shows a trading profit of £68,456, against £204,635 in the previous year. After making all allowances there was a balance of profit of £8,519, which was carried forward. The decline in productivity in the Yenangyaung and Singu fields continues, but efforts are being made to discover and open up fresh sources of supply.

DIVIDENDS DECLARED

Anglo-Burma Tin.—3d., less tax, payable December 15.

Ariston Gold.—3d., less tax, payable December 14.

Associated Gold.—6d., less tax, payable January 17.

Blackwater Mines.—1s., free of tax.

Consolidated Gold Fields of New Zealand.—6d., free of tax, payable December 31.

Frontino.—Pref. 1s. 6d., Ord. 1s. 9d., less tax, payable January 2.

Kleinfontein Estates.—6d., less tax, payable December 7.

London and Rhodesian.—3d., less tax, payable December 1.

Lonely Reef.—6d., less tax, payable January 30.

Luipaard's Vlei.—3d., less tax, payable January 17.

Malayan Tin.—3¾%, less tax, payable December 22.

Mount Lyell.—6d. (Australian currency), less tax, payable December 19.

Pahang Consolidated.—Pref. 3½%, less tax, payable December 22.

South Kalgurli.—1s., less tax, payable January 13.

Southern Malayan.—1½d., less tax, payable December 26.

South-West Africa.—1s. 6d., less tax.

Star Explorations.—1·2d., less tax, payable December 1.

Sungei Way.—2½%, less tax, payable December 23.

Taquah and Abosso.—4½d, less tax., payable December 1.

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

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

Wankie Colliery.—6d., less tax.

NEW COMPANIES REGISTERED

Gold Fields Australian Development.—Formed by the Consolidated Gold Fields of South Africa in partnership with the Transvaal Agency to open up new fields in the Commonwealth. Capital: £300,000 in £1 shares. Objects: To acquire lands, mineral and other rights, and to carry on all kinds of exploration work. The directors' borrowing powers are restricted to the amount of the nominal or authorized capital. Office: 49, Moorgate, E.C. 2.

Improved Metallurgy.—Registered as a private company. Capital: £50,000 in £1 shares. Objects: To develop new metallurgical processes for the manufacture of spelter and other metals or products, etc.

Metallization.—Registered as a private company. Capital: £60,000 in £1 shares. Objects: To acquire the business now carried on at Dudley, Worcs., as Metallization, to acquire any inventions relating to the coating of surfaces with metal, etc. Directors: C. H. Barwell, Sir Martin J. Melvin, A. H. Wellesley, E. H. M. White, W. E. Ballard, and A. S. Hollings.

Mosul Oil Fields.—Registered as a private company. Capital: £1,000,000 in £1 shares. Objects: To acquire the whole or any portion of the shares of the B.O.D. Company and to carry on the business of producers, refiners, and distributors of petroleum. The number of directors is ten, and will consist of five British nationals, three Italian, one French or Swiss, and one German. The Chairman shall at all times be a British subject.

N.S. Metal Investment.—Registered as a private company. Capital: £60,000 in £1 shares. Objects: To acquire and deal in all kinds of metals and ores, etc.

Rhodesian Prospectors.—Registered as a private company. Capital: £1,000 in 2,500 Ordinary shares of 4s. and 10,000 "B" shares of 1s. each. Objects: To prepare for market gold and all other metals. Directors: Chas. Merrick, Ernest S. Smithyes. Office: Bristol House, 19 and 20, Holborn Viaduct, E.C. 1.

United Lead and Zinc Mining.—Registered as a private company. Capital: £1,000 in 2s. shares. Objects: To acquire and turn to account any mines, mining rights, and metalliferous land in Cardiganshire or elsewhere. Office: 11, Queen Victoria Street, E.C.