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EDITORIAL

THE annual dinner of the Institution of Mining and Metallurgy is to be held this year at Grosvenor House, Park Lane, W. 1, on Wednesday, the 26th inst., under the presidency of Dr. S. W. Smith.

BY the death of Lord Chelmsford the working miner in this country has lost a good friend. For ten years he was chairman of the Miners' Welfare Fund Committee, from which he only resigned in order to preside over the commission of inquiry into the working of the fund.

THE holiday course in economic geology is being conducted by Mr. E. H. Davison, at Camborne, from July 10 to August 19, as in previous years. Mining men on leave or at liberty for other reasons will find in it an opportunity to freshen their memory. Enquiries should be addressed to the Secretary, Camborne School of Metalliferous Mining.

PLANS are now mature for a World Petroleum Congress, to be held in London from July 19 to July 25 under the auspices of the Institution of Petroleum Technologists. Membership is open to all and sessions will be held at the Imperial College, South Kensington, daily. Concurrently there is to be an oil industries exhibition at the Agricultural Hall, Islington, when oil well drilling plant and other equipment will be shown.

THE Sixteenth International Geological Congress is to meet in Washington, U.S.A., from July 22 to July 29. A schedule of the subjects for discussion has been issued, which also contains particulars of the excursions that have been planned. These include two transcontinental excursions, each of 31 days, and two of a shorter character —one for the study of the glacial geology of the Central States and the other to the pre-Cambrian area, which contains the iron and copper deposits of the Lake Superior region.

THE Institution of Mining and Metallurgy has this year awarded its gold medal to Sir John Cadman, "in recognition of his work in the advancement of technical education and the development of the mineral industries and of his distinguished public services." The Consolidated Gold Fields of South Africa gold medal goes to Mr. C. A. Banks for his paper on "Air-Transportation of Gold Dredges in New Guinea" and the same company's premium conjointly to Mr. J. L. Francis and Mr. J. C. Allan for their contribution on "Driving a Mines Drainage Tunnel in North Wales." The William Frecheville Students' Prize is awarded to Mr. G. J. Williams for his paper on "The Genesis of the Perrunal-La Zarza Pyritic Ore-Body, Spain."

FITTING tributes are being paid this month to the memory of a great Cornishman, Richard Trevithick, in connexion with the commemoration of the centenary of his death. It will be recalled that a memorial was unveiled at Camborne in May of last year and it is now proposed to erect others at his birthplace, Tregajorran, at Pen-y-daren in South Wales, where he ran his first steam rail locomotive, and near the Euston Road. On Sunday, April 23, memorial services are to be held in Westminster Abbey and elsewhere and on the following day Professor Inglis is to deliver a lecture before the Institution of Civil Engineers. A special exhibition of examples of his engines and other objects relating to his work is on view at the Science Museum until the end of June. It is interesting to note that the old winding engine at the Levant mine, which dates back to the days of Trevithick, is to find a permanent home at South Kensington.

The Institution Meeting

Distinct contrast in subject matter for discussion was provided by the two papers presented at the March meeting of the Institution. In the first place, in the paper entitled "Notes on Power used in Crushing Ore, with special reference to Rolls and their Behaviour" Dr. John S. Owens revived old controversies on the laws of crushing. The author is a consulting engineer to the Rio Tinto Company and contributed a paper to

the Institution in January, 1926, on a new instrument for bore-hole surveying. In the second paper—" Notes on the Origin of some Mining Terms "—Mr. Edward Halse explored the varied sources from which the miner's vocabulary has been enriched.

Rittinger and Kick are names well known to mining men, who will recollect the heated arguments that have arisen from time to time over the formulas propounded by these authorities for the calculation of the power required in crushing, and Dr. Owens in his paper once again takes up the cudgels. In the course of his argument the author first examines Kick's theory, which he sets out as follows :—" The energy required for producing analogous changes of configuration of geometrically similar bodies of equal technological state varies as the volumes or weights of these bodies " or, in other words, " Kick's law says that each time the volume of the individual ore particles is reduced by a constant divider the energy expended will be the same." Rittinger's theory, however, assumes that " the net work done in crushing is proportional to the area of new surface formed." It is evident, therefore, that the essential differences between the two theories is that, whereas the area of newly-fractured surface is taken in both as a measure of force, the distance through which the force must act is taken by Kick to vary with the diameter of the particle and by Rittinger to be constant. Dr. Owens made a study of what had been done by various workers seeking experimental confirmation of these laws and found the lack of agreement disconcerting. In the course of an examination of the new reduction plant at Rio Tinto, therefore, he determined to approach the problem from first principles in order that any theory evolved might be checked experimentally, the results of his investigation having been presented as a preliminary report to the Rio Tinto Company, which has permitted its presentation before the Institution. The author first discusses the various tasks in the carrying out of which the applied energy is used and sums them up as—(1) tearing apart the ore, (2) compression prior to breaking, including internal friction, (3) elastic distortion of the machine, (4) rubbing between pieces of ore after breaking, (5) rubbing between ore and machine, (6) sundry losses, and (7) mechanical friction of the machine. Examination of these items in turn finally suggested several new formulas capable of partially solving the problem, one constantly recurring factor appearing to be particularly important. This, which the author states as $\left(\frac{D}{S} - \frac{S}{D}\right)$—where D is the feed diameter and S the roll setting—has been found to vary almost directly with the net power used and, with the calculation of suitable constants, may afford valuable information for any particular set of tests. The paper, however, does not pretend to give the author's final conclusions, but describes a novel line of approach to an important subject and it is likely to be of great help to future workers. Discussion was initiated by Mr. R. T. Hancock, who has, as readers of the MAGAZINE will recall, made an intensive study of the subject, others taking part being Messrs. J. H. Watson, F. Yeates, and T. J. Taplin, Dr. Owens replying to most of the points brought up. While the subject of crushing may be somewhat overpowering to the average mining man, it is evident that Dr. Owens' work is of the utmost importance to those interested in the mathematics of ore-dressing.

Mr. Halse's paper afforded a refreshing change after the mass of formulas and complicated argument that had been aroused by that which preceded it. The author has delved deep into the origin of mining terms, making them his special study and evidently prizing a novel term as a collector treasures a new specimen. He gives examples of words derived from languages that are dead and from those still living, of some of Biblical derivation and of others taken from natural history. Some terms have been applied to indicate a resemblance, fancied or real, to natural objects or to objects in common use, some are taken from other arts, from the sea and the fighting forces, and from agriculture, while the colonies and local dialects have contributed their quota. Many terms have doubtful origin, but it is evident that the miner's vocabulary—like any other language—is singularly rich in derived terms and its study is not without interest. The remarks of Professor Lawn, who opened the discussion, illustrated the wealth of folk-lore that is buried in the miner's own language, the history of migration that is revealed by its study, and the ingenuity that belongs in peculiar manner to those who practise the art. Mr. R. S. Botsford, who followed, showed how familiarity with local terms may be of immense value in the interpretation of old records, while Mr. Yeates dwelt on the intellectual profit that may be derived from the pursuit of work such as Mr. Halse has carried out.

The New Policy on the Rand

In the February issue of the MAGAZINE the position of the gold-mining industry of the Witwatersrand, on the Union's departure from the gold standard, was reviewed and on that occasion a speech that had recently been given by Mr. John Martin, outlining the views of the gold producers and setting out the new policy they were likely to pursue, was used as a text for our remarks. At that time the South African Mineworkers' Union had caused a certain amount of anxiety by a demand for a 35 per cent. increase in wages, a demand that was subsequently refused by the producers, whose attitude was, no doubt, tacitly approved by the Union Government. The workers are now pursuing a more conciliatory course and are seeking to reopen discussion with the Chamber of Mines. At the annual meeting of that body, held in Johannesburg last month, Mr. Martin stated that the owners are ready to arrange a meeting with the workers, so there are evidently some matters justifying discussion, and his speech on that occasion is of sufficient importance to warrant further examination of the situation after three months' working under the new conditions.

There would seem to be three main uncertainties that have to be taken into account at the present time in reviewing the position of the Rand. First, there is the wages question, already referred to. In view of what has been said, it is possible that some day an advance in the wage level will take place, but unless the workers' union has more secure grounds than those upon which it based its first demand—the depreciation in their wages in consequence of the devaluation of the South African pound—it is unlikely to secure what it desires. Cost-of-living figures are always uncertain, as they are usually based on statistics obscurely derived—obscurely, that is, to the lay mind, for they are doubtless perfectly clear to those who work them out. Nevertheless, it has to be taken into account that the cost-of-living index determined by the Union Census Department fell by nearly two per cent. from December to January last, while it has fallen by more than 15 per cent. since the existing wages agreement came into force, so that until an increase in the price level is witnessed some other ground for a rise in wages will have to be found to justify any change. It is probable that the mineworkers will continue to feel a grievance that the increase in the profits enjoyed by the mines under the new conditions is not shared by them and it may be that wage concessions will eventually be made with a view to removing an apparent unfairness. It has to be remembered, however, that there are both high-cost and low-cost producers, so that a standard increase in the wage level hardly seems equitable, and it is evident that the situation will call for diplomatic handling. So much for the wages question.

On the subject of taxation, which is next in importance, Mr. Martin pointed out that the present scale of direct and indirect taxation in South Africa is very high and he was, no doubt, quite right in warning the Government that if taxation was increased too suddenly its effect might be crippling, but in reminding his hearers that the industry was the mainstay of the Union he was probably stating the very reason that might make it necessary for those responsible for the Union's finances to look to it for the support of a dwindling revenue. Here again a careful study of the situation is needed, for, as Mr. Martin explained, no measures must be adopted that are likely to retard the expansion of the industry, restrict the mining of lower-grade ore, or discourage the inflow of fresh capital for development purposes. Coming to the third uncertainty—the future of gold—apprehension has been felt in some quarters that the world could do without it as a standard of value or might attempt to do so. In this connexion Mr. Martin referred to the situation that would arise if the countries still remaining on a gold standard were to depart from it. In his opinion—and in that of most other people qualified to judge—such fears are, for the present at any rate, groundless. Although a general revaluation of currencies may be called for and is, indeed, temporarily sought by those countries that abandoned the standard, it seems evident that such steps are really only strengthening the position of gold, for there is no sign of any substitute for that metal as a satisfactory international standard of value being forthcoming and all depreciated currencies are still measured in terms of it.

Having considered the uncertainties affecting the Rand mining industry, the working of the new mining policy in the Union is worth examination. At the special meeting of the Chamber of Mines held in January Mr. Martin expressed the view that

under the altered conditions prevailing in the Union the policy of the industry would be one which would grasp the opportunity of expanding operations and of prolonging the life of the mines. Already considerable progress has been made in this direction and as early as February the average yield for the whole industry had been lowered by 0·317 dwt. per ton milled as compared with the previous December and it is expected that this general reduction will continue. In addition, as Mr. Martin indicated, several programmes involving heavy capital expenditure have been adopted and many development schemes initiated, which may be accepted—to quote his words—as "unmistakable proof of the determination of the mines to follow to the fullest extent a policy designed to strengthen and broaden the whole basic position of the industry" and, it might be added, as evidence that a policy of life extension has been placed before an evanescent increase in profits.

Empire Mineral Resources

During the War the dependence of this country on extra-Imperial sources for certain mineral supplies was unpleasantly emphasized and, although the organization speedily evolved for overcoming the difficulties of the situation was admirable for its purpose, work of a greater degree of permanence was patently necessary and in these columns the progress of the correlation has been closely followed. The matter came once again to the fore on the occasion of the last Imperial Economic Conference, when, as the meeting was held in Canada, much of the preparatory work devolved on the Dominion authorities. In the last issue of the *Canadian Mining and Metallurgical Bulletin* Mr. A. W. G. Wilson, chief of the Division of Mineral Resources in the Mines Branch, Ottawa, summarizes the preliminary investigations undertaken by his department and his description deserves examination.

The early work in this country initiated during the War needs no review here, but certain outstanding events may be recalled. In July, 1925, the Imperial Mineral Resources Bureau became the Mineral Resources Department of the Imperial Institute and with this Department all the technical organizations of the Empire interested in the mining industry are associated in an advisory capacity. At the same time it has to be remembered that the importance of correlation has been repeatedly brought forward at the various Empire Mining and Metallurgical Congresses, Lord Long of Wraxall, Sir Thomas Holland, and Dr. Charles Camsell having opened discussions on the proposed review of the mineral resources and industries of the Empire and the conditions affecting their development. As a result the Empire Council of Mining and Metallurgical Institutions passed resolutions that were subsequently discussed at the Imperial Economic Conference held in London in 1930, a Minerals Committee being appointed which delegated appropriate tasks to the individual Governments of the Commonwealth, the results of the separate surveys to be brought together by the Department at the Imperial Institute. It was decided to obtain data concerning 49 leading mineral products, a series of questionnaires being prepared in order to obtain uniform replies, these dealing with mineral deposits, production of ores and minerals, production of metals, imports and exports, consumption, smelting and refining facilities, and supplementary data. This work in Canada required the nearly continuous employment of a staff of ten persons for about ten weeks, which serves to show the seriousness with which the problem has been tackled. Finally the data from all parts of the Empire were assembled in London in June of last year, an interim report being issued for use at the conference, and one of the principal features incorporated was a table showing the different mineral resources of the various parts of the Empire.

It is interesting to learn that the mining industry was the only group-industry based on natural resources that had accumulated uniform data throughout the Empire and correlated it through a central committee. The Ottawa authorities have, using the interim report as a nucleus, compiled complete and elaborate data for their own use, a series of reviews having been prepared, as well as statistical data covering periods of five and nine years. The Mineral Resources Department of the Imperial Institute, in a survey published in 1931 and reviewed in the MAGAZINE for March of that year, showed how near the Empire was, when considered as a unit, to mineral independence, a fact which was driven home further by Dr. Charles Camsell at the annual convention of the Canadian Institute of Mining and Metallurgy a year ago, so that, with the additional evidence now available, the mining industry can claim its just position as the keystone in the arch of Imperial unity.

REVIEW OF MINING

Introduction.—The banking crisis in America has, as was expected, been surmounted and already modifications have been made in the gold embargo that was imposed a month ago. It seems probable that preparations for the World Economic Conference will now be hastened, while Anglo-American trade concessions are being discussed in Washington. In South Africa rumours have been current with respect to the intentions of the Government regarding new taxation, but it is unlikely that anything will be done before the General Election. Base metals are generally better and there are rumours as to a possible closing of the U.S.A. copper mines for the summer months.

Transvaal.—The output of gold on the Rand for March was 896,728 oz. and in outside districts 50,135 oz., making a total of 946,863 oz., as compared with 883,145 oz. in February. The number of natives employed in the gold mines at the end of March totalled 223,490, as compared with 222,589 at the end of February.

It has been announced by the West Witwatersrand Areas that in boring on the farm Driefontein No. 105 coal seams were intersected at 219 ft. and 331 ft., the first having a thickness of 42 ft. and the second 16 ft. The company has secured coal rights over all the options held.

The directors of the Vogelstruisbult Gold Mining Areas have announced that with a view to the more rapid development of the company's property it has been decided to proceed immediately with the sinking of a vertical shaft and preliminary arrangements to that end are now in hand.

Last month an issue of 187,500 new shares of Sub Nigel was made, at 110s. per share, the proceeds to be utilized for the erection of a new treatment plant having a capacity of 50,000 tons a month and for the sinking of a new vertical shaft to an estimated depth of 5,300 ft. This policy does not affect the decision to increase the capacity of the old plant, referred to in the MAGAZINE last month, where the additions will be completed by July next. Early this month it was announced that the company had obtained an interest in a new project connected with the opening up and development of the farm Vlakfontein No. 8, situated on the northern boundary of the Sub Nigel. This property is held by Lace Proprietary Mines, which will sell to the new company for £325,000, to be used for subscription for 650,000 of its 10s. shares. New Consolidated Gold Fields, Ltd., is to tender for a lease and if this is accepted by the Government will form and register the proposed company, the initial capital of which will be £675,000 in 10s. shares. It is understood, however, that the other leading finance groups on the Rand are also interested in the flotation. The new shaft on the Sub Nigel is to be expedited and an incline sunk therefrom on to the Vlakfontein property for exploration purposes.

The report of Rand Mines, Ltd., for 1932 shows the profit to have been £562,282, to which must be added £466,711 brought in, £100,000 written back from general reserve account, and £13,690 from sundry items, giving an available total of £1,142,683. Of this amount taxes absorb £25,572, while dividends paid during the year took £409,030, leaving £708,081 to be carried forward.

It was announced last month that the Rand Selection Corporation had sold 50,000 reserve shares at 15s. each, subject to calls on the remaining reserve shares.

A fire in the Langlaagte Estate mine early this month resulted in several deaths, operations being suspended for two or three days.

The accounts of the Union Corporation, Ltd., for 1932 show a profit of £256,058, which, added to £113,972 brought in, gave an available total of £370,030. Of this sum £221,725 is to be distributed as a dividend, equal to 3s. 6d. per share, while £30,000 has been placed to reserve, leaving £118,305 to be carried forward. The reports of the Modderfontein Deep, Geduld Proprietary, and East Geduld companies are summarized elsewhere in this issue. The property of the last-named company is developing satisfactorily and two inclines are being driven towards the boundary with the Grootvlei property in order that initial prospecting may be started, but it is not expected that the first incline will be completed until next year. Boring operations are under way on the Vlakfontein No. 21 and Draaikraal No. 296 areas, where the corporation has option rights.

During 1932 the Anglo-French Exploration Company made a profit of £37,398, which, added to the sum brought in, gave a total of £64,275, of which £31,500 has been

distributed as a dividend, equal to 6%, and £2,000 written off, leaving £30,775 to be carried forward. The revaluation of the company's assets at the end of the year showed a surplus of £39,517, as compared with a deficit of £83,565 at the end of 1931.

Preliminary figures issued by the General Mining and Finance Corporation show that a profit of £229,378 was earned for 1932, making with the £14,797 brought in an available total of £244,175. A dividend equal to 10% has been declared and after allowing for this and other items there remained £110,740 to be carried forward.

The accounts of West Rand Consolidated for 1932 show a profit of £324,669, dividends declared during the year absorbing £132,812, equal to 6¼%. The tonnage crushed at 1,135,000 shows an increase of 69,000 tons over the figures for the previous year, while the value of the gold yield was £1,277,691, against £1,217,901. The treatment costs decreased from 18·48s. to 17·28s. per ton, the profit increasing from 4·37s. to 5·23s. The ore reserves at the end of the year were estimated to be 5,028,000 tons, averaging 5·3 dwt. in value over a stoping width of 45 in., as compared with 5,018,000 tons, averaging 5·2 dwt. over 46 in., at the end of 1931. During the year the South shaft was sunk 3,690 ft. to a total depth of 3,776 ft., intersecting the reef at 3,613 ft.

At the annual meeting of the East Rand Consolidated, to be held this month, it will be proposed that the value of the shares be reduced from 10s. to 5s. and, further, that the capital be increased to £1,000,000 in 5s. shares. The company then proposes to acquire from the African and European Investment Co. mineral rights in the South-East Rand in return for £300,000 in shares.

Southern Rhodesia.—The output of gold from Southern Rhodesia during February was 47,661 oz., as compared with 48,656 oz. for the previous month and 45,032 oz. for February, 1932. Other outputs for February were: Silver, 8,215 oz.; coal, 33,337 tons; chrome ore, 3,710 tons; asbestos, 1,872 tons; mica, 1 ton; iron pyrites, 1,808 tons.

The report of the British South Africa Company for the year to September 30 last shows a profit of £172,900, making, with the sum brought in, an available total of £820,384, which was carried forward. No dividend was declared for the year under review, the question of the company's liability to income tax not yet having been decided. Our Rand correspondent in his letter this month refers to the agitation over the ownership of mineral rights in Southern Rhodesia, but since his letter was written the Government of the Colony has offered to purchase these for £2,000,000. This offer has been accepted, provided the company's obligations are also taken over.

Northern Rhodesia.—Reference to the quality of the copper produced by the Roan Antelope mine was made at the annual meeting of British Insulated Cables last month, when the chairman was dealing with the formation of British Copper Refiners, Ltd., to operate a newly-constructed refinery at Prescot. The refinery started work on January 4 last and has since maintained regular production, the output being manufactured into finished wire products, which, under test, have never yet failed to comply with the British Standards Institution requirements.

Shareholders of Luiri Gold Areas have been informed that response was insufficient to proceed with the suggested creation of £40,000 in debentures and that another scheme for raising working capital is under consideration.

Gold Coast.—The output of gold from the Gold Coast during 1932 was 318,430 oz., as compared with 273,514 oz. the previous year. The output of diamonds was 842,297 carats, against 880,479 carats, and of manganese ore 50,689 tons, against 247,191 tons. At the end of last month it was announced that the Colonial Treasury intended to impose an export duty of 15% on the price of gold above 84s. 11½d. per oz., with certain allowances which will tend to stimulate the exploitation of low-grade properties.

A circular to shareholders of the North Ashanti Mining Company states that owing to arrangements for providing working capital having fallen through the company proposes to proceed with the issue of £25,000 in 8% 5-year convertible notes, to which shareholders will have a prior right to subscribe.

At an extraordinary meeting of Ashanti-Obuasi Reefs, Ltd., last month it was approved that every four 3d. shares of the 3,000,000 shares issued be converted into 1s. shares.

An extraordinary meeting of the Anfargah company is to be held this month at which it will be proposed that the company should go into voluntary liquidation, its assets to be divided among the shareholders.

Shareholders of Lyndhurst Deep Level have been informed that if sufficient funds can be found it is proposed to reopen the mine and resume active operations.

Nigeria.—The report of Lower Bisichi (Nigeria) Tin Mines for the year to September 30 last shows a profit of £350, increasing the credit balance brought in to £2,978, from which a dividend of 2½% is to be paid, reducing the amount carried forward to £2,068. The output of tin concentrates was 42¼ tons, against 71 tons the previous year, the price realized being £94 10s. 7d. per ton, against £79 18s. 6d. The advisability of closing the mine is under consideration.

Australia.—For some time the South Kalgurli has been working the Croesus Proprietary on a profit-sharing basis with the North Kalgurli and it has now, as the result of trial crushings, taken an option over two adjoining leases.

In the return for February shareholders of the Wiluna Gold Corporation were informed that the shaft on the Essex lease had been unwatered to the 200-ft. level, where old workings sampled over 40 ft. averaged 32s. per ton. Preparations are being made for exploring the lode at this level.

Good developments at the Lake View and Star and the Great Boulder Proprietary were announced last month. The new east lode on the former mine has opened up well on the 1,400-ft. and 1,800-ft. levels and has been cut on the 1,200-ft. level. On the Great Boulder two good ore-bodies are being opened up, one from the Lane shaft at the 900-ft. level and the other from the Hamilton shaft at the 1,800-ft. level. Cross-cutting is also in progress with a view to intersecting the new east lode discovered on the Lake View. On the Sons of Gwalia good results are shown in the development report issued with the March return.

India.—A rockburst in Rowse's auxiliary shaft on the Mysore mine at the end of last month resulted in the death of five employees and injuries to others. The damage was not extensive and was not expected to interfere with the output.

Malaya.—It has been announced that the Kamunting Tin Dredging Company is to repay debentures due on October 31 next and October 31, 1934, reducing those outstanding to £64,000.

It was decided last month that the Malayan and General Trust should go into voluntary liquidation, a new company being formed, with a capital of £200,000 in 4s. shares, which would be allotted to existing shareholders credited as 2s. 10d. paid. The new company will subscribe for 126,000 5s. shares in Kamra Tin Dredging at par, subject to the repayment by that company of its debentures at 110, half in cash and half in shares. The £40,000 debentures of the Malayan Trust are to be redeemed by the allotment of five 5s. Kamra shares for each £1 of stock.

Korea.—A circular to shareholders of the Chosen Corporation issued last month stated that the expedition leaving on March 10 was in charge of Mr. R. J. Morgan.

Holland.—An announcement issued by the Billiton Tin Company last month stated that a new large tin smelter was to be erected in Holland, where its subsidiary company, the Hollandsche Metallurgische Bedryven, already operates a small plant at Arnhem. It is said that the entire output will be smelted in Holland in future.

Cornwall.—Shareholders of Geevor Tin Mines, Ltd., were informed this month that the outstanding amount of 7% credit notes would be repaid on June 30 next.

Consolidated Mines Selection.—The report of the Consolidated Mines Selection Co., Ltd., for 1932 shows that after adding £2,125 brought in from the previous account there was a sum of £14,139 available for distribution. Of this amount £4,607 has been written off certain assets, the book value of shareholdings now standing at £464,530, against a market value of £374,865 at the end of the year. After making various other allowances a sum of £4,955 was carried forward.

Imperial Chemical Industries.—The accounts of Imperial Chemical Industries for 1932 show a profit of £4,729,072, as compared with £3,408,290 for the previous year. The gross income for the year amounted to £6,415,423, from which £1,000,000 was allocated to the obsolescence and depreciation fund and £686,351 to income tax reserve.

Minerals Separation.—During 1932 Minerals Separation, Ltd., made a profit of £32,141, against £33,948 for the previous year. The credit balance brought in amounted to £52,850, of which £30,000 was distributed as interim dividends during the year. A final dividend of 2s. per share has been declared, absorbing a further £20,000, and, after making other allowances, a balance of £29,934 was carried forward.

THE NORTHERN RHODESIAN COPPER FIELDS

By WILLIAM CULLEN, LL.D., M.Inst.M.M.

This article, which is intended to serve as a general introduction to a series descriptive of practice in Northern Rhodesia, is mainly historical, tracing as it does the discovery and subsequent development of the field.

This description of the Northern Rhodesian copper fields is in the main a review of the history of the discovery and subsequent development of these wonderful deposits. In order to obtain correct perspective, however, it has been thought desirable to refer to some apparently extraneous matters that have a most important bearing on the subject from the Empire point of view, for until only five or six years ago the Empire occupied a very humble position with regard to copper production. To-day, thanks to Northern Rhodesia and Canada, that has all been changed and even at this early stage it may be stated that the Empire from its known reserves could easily be put into a position to supply the requirements of the whole world for many years to come. It is a matter of great gratification to the writer that he has known many of those connected with these discoveries in the pre-production days and since. In this connexion his Belgian friends must not be forgotten, for their pioneer work and subsequent enterprise really blazed the trail for those who came after them in Northern Rhodesia.

Towards the close of the 18th century a Dr. Lacerda was sent out by his Government to administer Portuguese Zambesia and to explore the unknown country lying between Portuguese East and Portuguese West Africa. Writing from Tete in 1796, after hearing of the landing of a British force at Capetown in that year, he predicted that the British would not only drive a wedge between these two Portuguese possessions, but that they would ultimately push ever northward till they reached the Nile, a remarkable prophecy. Many years later, in 1875, Stanley started on his remarkable Trans-African journey, at the instigation of that far-seeing monarch, King Leopold of Belgium, this expedition ultimately leading to the creation of the Congo Free State. References had been made by Livingstone and Cameron, who had accompanied Stanley on an earlier expedition, and by others to the mineral wealth of the Katanga, the south-eastern portion of the Congo State. Rhodes, getting to learn of these, sent one of his emissaries, Mr. (now Sir) Alfred Sharpe, to the district to make treaties with the dominant chief. As, however, the Katanga was included within the area of the new State nothing could be done, but meantime the Katanga Company was formed in Brussels in 1890 with a capital of 3,000,000 francs. A large proportion of this was subscribed by English capitalists and Cameron, whose name has already been mentioned, was on the board. This company sent out two expeditions—one, under Captain Stairs, travelled in from the east ; the other, under Messrs. Bia and Francqui, entered the interior by the west, via the Congo, returning to Belgium in 1893. With this latter party was a Monsieur Cornet, a geologist, who apparently not only made a detailed geological examination of the area, but actually located ten copper deposits. His conclusions, undoubtedly sound at the time, were :—" Unfortunately the relatively low value of these ores and the remoteness of the deposits exclude for the moment any idea of exploitation." Cornet could not and did not visualize the immensity of some of these deposits, but he did know, apparently, that they were both silicious and oxidized and, therefore, difficult to treat by the processes then known. He also knew that no fuel excepting wood was available for smelting. The expedition which had entered the area from the east suffered very severe privations and nearly succumbed to famine. The report of these two expeditions was published in Belgium in 1894.

Meantime to the south history was being made rapidly and Rhodes, who was during this period at the height of his power, had secured for Great Britain, through the establishment of a protectorate over Bechuanaland, that corridor to the north which Lacerda had visualized one hundred years before. He obtained his charter from the British Government to administer the country and to possess all the minerals in what is now known as Southern Rhodesia in October, 1889. If he had not stepped in with promises of financial support at that particular time the country would most likely have been lost to the Empire for ever. Whatever one may think of Rhodes and his methods—and he has plenty of critics even to-day—he was undoubtedly the man whom posterity should thank for the acquisition of the Northern Rhodesian copper fields.

The rapidity of development in the two

Rhodesias is well illustrated by the following calendar of dates :—

Rhodes sent up his first party of 500 pioneers to occupy the country effectively and they established themselves at Salisbury in 1890.

The railway reached Mafeking in 1892; Bulawayo, 1897; the Victoria Falls, after a halt at Wankie, in 1904; Broken Hill, 1906; and, after another halt, it reached the Congo frontier in 1909, Elizabethville in 1911, and Bukama, on the navigable Congo, in 1918.

At this stage some very commonplace generalizations may be made. One is that most countries which have subsequently become great have had their development hastened through the discovery of mines. A second is that mines cannot be developed without an efficient transport system and in this connexion the particular case of South Africa is most interesting. Broadly speaking it was the diamonds of Kimberley which took the Cape railway to that city. It was the discoveries of gold on the Rand which took it a stage further north to Johannesburg. It was the lure of potential mineral wealth which extended it to Rhodesia and the discovery of coal which took it to Wankie. Zinc, lead, and subsequently vanadium took it to Broken Hill and the great Katanga copper deposits justified the extension of the system to Elizabethville and then still further north. It is doubtful, indeed, if the discoveries of the copper fields of Northern Rhodesia would ever have been made had not the railway been built to Katanga.

The charter which was granted to Rhodes and his associates in 1889 was bounded by the Zambesi to the north, but during the next few years Rhodes, through agents, was able to secure the mineral rights of all the country now known as Northern Rhodesia. The Chartered Company was, therefore, in the extraordinary position of not only being responsible for the administration of a country many times the size of the British Isles, but owner of all the minerals underlying the soil. Let it be said, too, at this stage that, though their administrative functions have now been taken over by the Responsible Government of Southern Rhodesia and by the Crown Colony Government of Northern Rhodesia, the Chartered Company's record is not one of which they need be ashamed.

So much, then, for Rhodes and the Chartered Company. Southern Rhodesia was gradually building up its mineral industry and had made very considerable progress when the Boer War broke out in 1899. Then other personalities come into the picture, the most important of whom are Robert Williams (now Sir Robert) and George Grey, a brother of Viscount Grey of Falloden. Williams had sent an expedition to the far north in 1895, but it failed to discover any mineral deposit of value. In 1899 he formed the Tanganyika Concessions, Ltd., with the modest capital of £100,000, to exploit a concession of 2,000 square miles in Northern Rhodesia granted by the Chartered Company. Subsequently his company secured a mineral concession in the Congo Free State of 60,000 square miles. Out of this small beginning grew the Union Minière, Tanganyika Concessions, the Benguela Railway Company, and the Rhodesia-Katanga Company. To exploit his Northern Rhodesian concession Williams fitted out an expedition under Grey in 1899 and he has since admitted that this was a pure adventure. However, Grey not only located the Kansanshi mine in Northern Rhodesia but also the very rich deposits over the border which are now being exploited by the Union Minière and which had been mentioned by Cornet eight years previously. It should be recorded at this stage, however, that Williams had commenced negotiations to secure a mineral concession in Katanga before he had received any sort of report from Grey. In this connexion it has already been stated that his efforts were successful and it might be added that ultimately Tanganyika Concessions received a 40% interest in the Union Minière. Rhodes was one of the original shareholders in the company.

On Grey's return a third and larger expedition was sent up to the Kansanshi mine and simultaneously another party, under Mr. M. J. Holland, set out from Abercorn with instructions to meet Grey at the Lunga River. Naturally news of these doings reached Belgium and, although there had been some excitement caused by Grey's report of great gold discoveries, it had quite died down by 1900, according to the December issue of the *Mouvement Géographique*. At the meeting of the Tanganyika Concessions held on November 30, 1900, it was announced that—"George Grey, leading an expedition from Bulawayo, had discovered in Northern Rhodesia the most extensive gold-bearing region which had ever been seen north of the Zambesi river and he anticipated an extension of the same into Katanga."

KANSANSHI CAMP IN 1902: PHOTOGRAPH FROM THE HILL, LOOKING SOUTH.

An extract from a paper by Monsieur H. Buttgenbach—read before the Royal Belgian Colonial Institute and reported in the *Echo de la Bourse* for February 1 last—may be usefully interposed at this stage :—

It must be admitted that news of this kind had as result to hasten, on the one hand, the creation of the Katanga Special Committee, which were entrusted with the management of the Katanga territory, and, on the other, the Tanganyika Concessions, with a view to prospecting operations being undertaken in Southern Katanga, on terms reserving for the Committee and, consequently, for the State a substantial share in any discoveries made. May I be allowed to add at this juncture that we found in Sir Robert Williams—the animator which he then was and has since remained—a man whose correctness had never ceased to be appreciated and who ever since has worked with his Belgian colleagues in a spirit of cordiality unceasingly tending to safeguard mutual interests.

Having left Belgium in 1902, to follow the prospecting operations which were being undertaken in Katanga by George Grey, I had obviously seen Cornet on several occasions before my departure ; he had certainly spoken to me about the copper mines, but I wish to repeat that neither he nor the management of the Katanga Special Committee had foreseen the possibility of working this metal. All hopes were concentrated on gold and it was also with this hope in mind that I set out on my journey. When, after travelling by the Zambesi, Nyasaland, Tanganyika, and Moero, I eventually arrived in Katanga—at Lukafu, which was then the southernmost post of the Committee—I was unable to ascertain where the English prospectors were. I continued my journey haphazardly towards the south and I still remember the day when I saw in the distance, looking through my glasses, the English camp, including four sets of tents well aligned on the slope of a hill. A few

SMELTER WORKING AT KANSANSHI MINE, 1908.

hours later, about midday, I arrived at the camp and met, standing near a mud-hut the "second in command" of the expedition, Michael Holland, with whom I subsequently entertained the most cordial relations. He offered me, in accordance with the usual custom, a simple but substantial lunch, during which I asked him how the gold prospecting work was progressing. He answered me that he did not know, but that he was working a fine copper mine. I asked him how many men he had with him; he answered that he had but one miner. But then, I said, what is the reason for these tents I saw in the distance? Tents, he answered, we have no longer any tents since building this hut; you must have been mistaken. And, in effect, whilst visiting, in the course of the afternoon, the copper mine referred to I noticed that what I had taken for four sets of neatly-aligned green tents were in reality four belts of green malachite ore extracted from four parallel trenches created for the purpose of studying the deposit. We were standing on the Kambove mine. I showed Holland the description of the mine which had been made by Cornet; he knew nothing of it, nor did George Grey. I need not add that Cornet's work was most useful to us subsequently and much facilitated the investigation and development of the other deposits.

To complete the record it should be stated that an American mining engineer named Farrell visited Katanga in 1903, but his reports were so optimistic that no one believed him. Shortly afterwards information of these phenomenal discoveries percolated down to Johannesburg and an expedition went up north, but returned with reports of exactly the opposite nature.

It seemed hardly logical to assume that providence had located all the rich copper deposits to the Belgian side of the border and, although the Kansanshi mine had been located and the Bwana M'Kubwa malachite outcrop some few years later, the various exploration companies inaugurated by Sir Edmund Davis and Mr. Percy Tarbutt, in association with the Chartered Company, had little to show for all their effort. True Collier, who discovered the Bwana M'Kubwa, had also located what is now known as the Roan Antelope, but no one took any notice. About 1910 Mr. Moffat Thomson, then a magistrate at N'Dola, had his attention directed to certain copper stainings by natives who were travelling with him. He pegged the claims, but, knowing nothing of either mining or geology, he sold them for £100 to a transport rider named Zeedeberg, who, in turn, transferred them to Donaldson and Sievewright, of Johannesburg. This turned out to be the N'Kana mine. It is interesting to recall the fact that only 11 years ago intimate friends of the writer in London had the option on these same claims, but could do nothing with them, London not being at that time copper-minded. The writer himself, having seen the outcrops both at N'Kana and Roan, however, is hardly surprised that they did not receive more attention at the time.

Sir Edmund Davis's name has already been mentioned and his early work after the Boer War has also been referred to. To him and to his associates is due the credit for having given a real impetus to mining in Northern Rhodesia. The Rhodesia Broken Hill Development Company started mining operations on the arrival of the railway in 1906, but work was soon suspended and operations were not started again until lead smelters were installed during the Great War. At Bwana M'Kubwa a 90-ton concentrator was erected in 1912 and metallurgical operations were commenced in January of 1913. Owing to a heavy drop in the price of copper the plant was closed down on the outbreak of War, but operations were resumed in 1916 and continued until March, 1918. The concentrates produced were sent to the Falcon mine, in Southern Rhodesia, where they were smelted. Still later on the mine started operations again, after an entire reconstruction of the metallurgical plant. It had come to be realized that the treatment of oxidized ore—the Bwana ore belonged to this category—was not an easy problem. The Perkins process of extraction by ammonia was adopted and production continued till the slump of 1929–30, when operations became unremunerative.

Both of the foregoing companies were controlled by the Edmund Davis group, but the Kansanshi (Robert Williams group) had also produced a few thousand tons of copper prior to the outbreak of the War. Up till the end of February, 1925, Northern Rhodesia had produced the following metals to the value stated:—

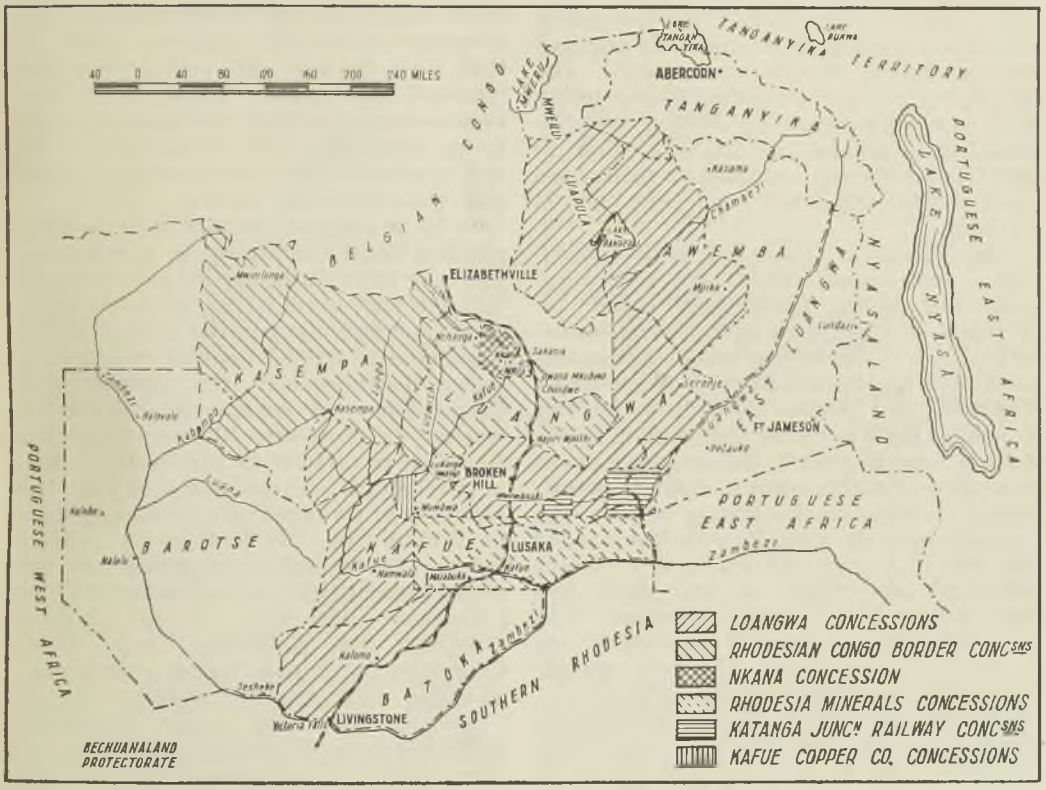
Lead	£2,482,965
Zinc Ore	88,653
Copper and Concentrates	622,924
Gold	78,940

This was something, but not very much, for almost 25 years of mining effort and yet it was sufficient to attract both the capitalist and the prospector, as the next few years show very clearly. It is worth noting that since the Roan Antelope started up in June, 1931, the value of the copper produced alone exceeds the total values which have just been given.

It is not possible within the limits of an article of this nature to do more than trace the broad outlines of development at this stage and obviously no account can be taken of the numerous companies which were formed to exploit the mineral resources of the country. At first sight it does seem strange, in view of the fact that Union Minière's main copper deposits were just across the border, that no intensive prospecting was done on the Rhodesian side, but the explanation is really very simple. These deposits on the Belgian side of the border were, it should be recalled, of phenomenal richness, going sometimes as high as 15% metallic copper. They were mainly malachitic and to a lesser extent silicious and in the early days even the tailings carried as much as 4–5% copper. The occurrences were in dolomite and, therefore, under alkaline conditions, and experience showed that instead of changing into sulphides at depth, as was expected, they simply became lean material, not worth working. It is now recognized that the geology on the Rhodesian side differs very considerably from that on the Congo side, but the fact remains that for quite a number of years people were looking for occurrences similar to those of the Congo and failed to find them. In other words, the Congo surface deposits were so obvious as to hit the eye, whereas those of Northern Rhodesia were inconspicuous and in effect mere stains.

It has already been stated that the Chartered Company owned the mineral rights of both of the Rhodesias and they decided in 1923 to grant mining concessions over large areas subject to certain reservations. It can be stated with absolute certainty that the real development of the mineral resources of Northern Rhodesia and particularly of the copper belt with which we are more immediately concerned only started from this time—that is, 1923. As new names have now to be brought into the picture an attempt will be made to describe in outline the principal events of the following few years.

Mr. P. K. Horner, who had been at one



Sketch Map, showing the Northern Rhodesian concessions in 1929.

time general manager of the Union Minière, conceived the idea of making a thorough job of prospecting for copper and, with excellent financial backing, he was largely responsible for the formation of a syndicate called "Copper Ventures, Ltd.," in which Minerals Separation held a 50% and Mr. Chester Beatty a minor interest. This was Mr. Beatty's introduction to Northern Rhodesia. The famous N'Kana mine subsequently came under the control of the syndicate, but by this time a concession of 1,800 square miles went with it. The potential mine, together with the concession, were ultimately acquired by the Bwana M'Kubwa company. The initial results were somewhat disappointing and, as a consequence, the Bwana company leased the balance of the concession to Mr. Chester Beatty, reserving to themselves certain rights which will have to be referred to later.

The Rhodesian Congo Border Concession, Ltd., was formed about the same time and was given prospecting rights for a period of years over 52,000 square miles of territory. This necessitated the engagement of a large highly-trained staff of geologists, engineers, and prospectors and, though this is not the place to record that work in detail, tribute must be paid to the enterprise of the company. Probably nowhere else in the world, except possibly on the Persian oilfields, has prospecting in the scientific sense been carried out on such a scale and with such a glorious disregard of expense, for the world was searched for men "skilled in the art" and even aircraft was given a great show. As a result several deposits, the most notable of which was N'Changa, were located.

Reverting for a moment to the subject of concessions the accompanying map shows clearly how the country was parcelled out at that time among the various concessionnaire companies, but it is quite impossible to record the individual results, as, outside of a small area adjacent to the Congo border, the discoveries made have not as yet been sufficiently tested.

About this same time Mr. Chester Beatty, on behalf of his company, the Selection Trust, sent out a young American mining engineer, Mr. R. J. Parker, to examine the Roan Antelope claims and the mineral prospects of the N'Kana concession, which had come under his control. It has been said that "it was Parker who first appreciated the existence of an enormous synclinal cupriferous basin or trough at the Roan Antelope and he was also the first to realize that beneath the leached surface showing at the Roan Antelope there lay many, many millions of tons of good sulphide ore." If Parker, however, was the first to appreciate the importance of the discoveries it was Mr. William Selkirk, a director of the Selection Trust, who was more responsible than any other man for their rapid development by drilling. Selkirk had great experience with massive formations such as iron-ore deposits, consequently his horizon was large and he acted accordingly. How remarkable the results obtained were is recent history, but it may be stated now that even the first drill-hole on the Roan disclosed high values. Indeed, it was these values which encouraged the Bwana company, to persevere with the exploration of the N'Kana mine, which, in due course, disclosed even more surprising results.

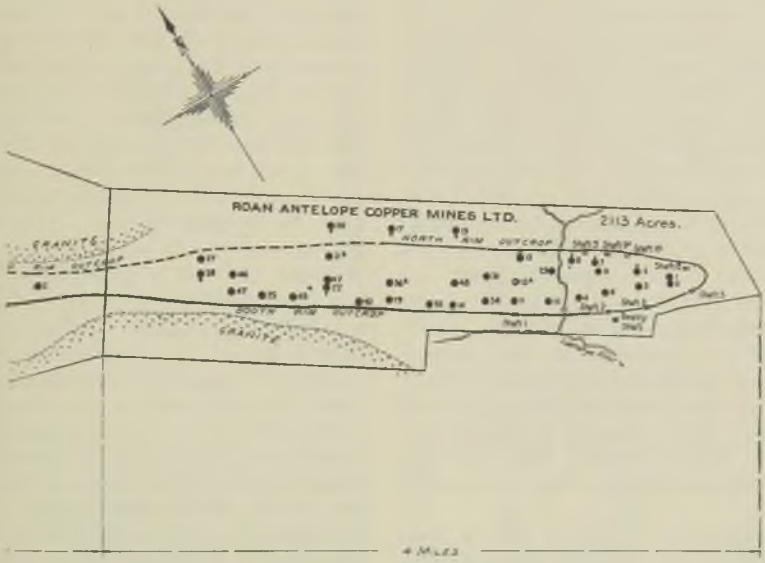
So far an attempt has been made to obviate mention of all but principals, whether companies or individuals, but one more company, and the last, must be named—that is, the Anglo American Corporation of South Africa. When the Chartered Company changed its policy of development, the Anglo American Corporation had commenced to take an interest in Northern Rhodesian ventures. Later on it decided to participate actively in the copper developments and in 1926 a branch of its organization was established at Broken Hill. By this time, too, it had become the consulting engineer, not only to the Broken Hill and the Bwana M'Kubwa companies, but also to the Chartered Company, the Rhodesian Congo Border Concession, and three other concessions—Loangwa, Kasempa, and Serenje.

For the next few years prospecting, geological mapping, drilling, and development were carried on with great intensity, with the result that phenomenal prospective tonnages were disclosed at the Roan Antelope, N'Kana, Mufulira, N'Changa, and Chambishi. The location of these is clearly shown on the map. In passing it should be recorded that practically all of these had been located either by prospectors or by natives many years before. Following upon these developments there was a period of intense financial activity and many names prominent in the world of finance, some new, some old, come into the picture. Among the Americans may be mentioned the Newmont Mining Corporation, Guggenheim's, and the American Metal Company. Among the British, apart from those which have already been mentioned,

are the Union Corporation, Rothschilds, the Rio Tinto Company, Johannesburg Consolidated Investment Company, and the Consolidated Gold Fields. The Chartered Company, owing to its mineral ownership, were naturally in everything as, very wisely, they took up their interest mainly in shares.

It cannot, however, be stated that finance was altogether easy. Reports of the discoveries naturally spread and many engineers eminent in the world of copper visited the new fields from time to time. Some of the reports which they made were optimistic, others were exactly the reverse, but on the whole optimism prevailed and, as a consequence, shares of the companies then existing soared sky high. This made finance easier and in the end plans were prepared for the equipment of the Roan, N'Kana, and Mufulira. The first two were carried out without substantial alteration, but the latter were modified very considerably so far as capacity was concerned.

It is well to recall the conditions which obtained in 1928–9 when decisions had to be made. Standard copper was standing round about £70–£80 a ton. The companies estimated that their costs would be between £35–£40 a ton. Statistics clearly showed that the consumption of copper had been increasing steadily over a great many years and that the new producers in Northern Rhodesia would only provide for this increased consumption. As a consequence the old-established copper producers would not be seriously interfered with and prices could be stabilized. Generally speaking the outlook was most hopeful and, if the speeches of some of the responsible protagonists of these days are re-read, the potential profits seemed astronomical. All of us are exceedingly wise after the event, but unless there had been abounding optimism at that time the fields would not have been developed and, as will be shown later on, the Empire could never have occupied the place which it now holds in the copper world.



General Plan of the Roan Antelope mine, showing the drilling programme in 1929.

It will be appropriate now to deal in brief outline with some of the more technical matters. The formation on both the Roan and N'Kana mines is synclinal. In the latter the copper-bearing lodes lie like a gigantic spoon which has been dug down into the earth at an angle, the upper rim of the spoon still showing at the surface. The actual material of the spoon itself represents the copper-bearing beds. The northern slope of the spoon on N'Kana has been tested mainly by drilling for a distance of 9½ miles and to a depth of 2,700 ft. The southern slope has still to be tested. On the Roan the formation is much the same as N'Kana in the east section, but in the Roan Extension, to the west, the ore-bodies of the north and south slopes open out fanwise and still further west in the Muliashi area the opening out becomes more pronounced.

Within the Roan area proper, which has a distance of just about four miles along the strike, both the north and south slopes have been tested by drills. In the case of both mines development in the generally accepted sense also took place and it can be stated here that the development results in the main confirmed those obtained by the drill. The width of the reef varies, but speaking roughly it may be put down at an average of about 20–30 ft.

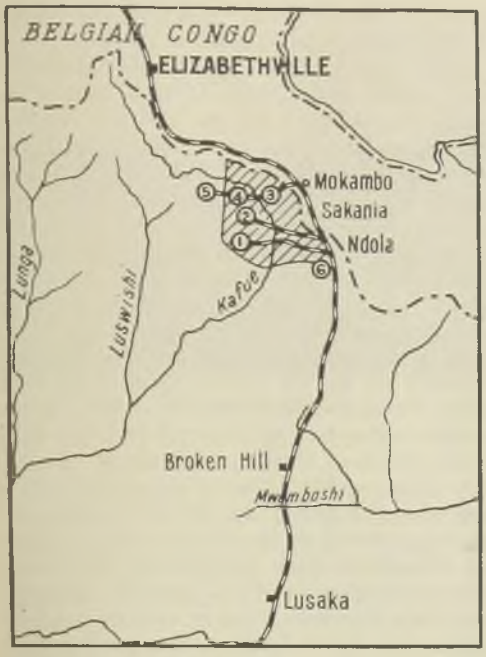
The two ore-bodies, although very different, have the same general characteristics. They are only fairly hard, so that drilling is not expensive, and the consumption of explosives is, therefore, distinctly low. Both are sulphidic, with a subsidiary oxide content, but, whereas N'Kana contains an appreciable percentage of cobalt, like some of the Union Minière deposits, the Roan ore is completely free of it. It may be said in passing that this cobalt may yet prove a most valuable asset. The ores of the N'Changa mine, on the other hand, are partly oxidized. The metallurgical treatment and general surface layout are much the same in both cases and no particular notice is taken of the oxidized content, which may be said to disappear in the tailings. Full details of the Roan plant have already been given in the issue of the MAGAZINE for November, 1930. Broadly speaking both ores produce matte readily and the subsequent production of blister presents no great difficulties.

From the foregoing sketch it will be seen that, whereas the ores of the Union Minière are of the oxidized type, those of Northern Rhodesia, apart from N'Changa, are of the sulphide type, thus presenting vastly different metallurgical problems. The Union Minière have tried nearly every known process of extraction and in the realm of the metallurgy of copper, and more particularly of that branch which concerns the treatment of oxidized ores, the company has been wonderfully successful. The writer understands that over 80% of the metallic contents are recovered. Sulphide ores, on the other hand, are easily and cheaply treated, as the costs, which will be referred to presently, very clearly show.

Coming now to the question of reserves it may be stated that actual development has indicated rather higher values than the drill. Drilling was stopped on all the properties when the aggregate results indicated a potential reserve of about 450 million tons—i.e., about 19 million tons of copper—but from a careful perusal of the records the writer hazards a guess that this figure can certainly be doubled and more likely trebled, without taking account of the Kansanshi reserves. The average grade of the copper mines of the U.S.A. may be taken as being round about 1·2% copper, whereas those of Northern Rhodesia are round about 4·25% copper.

The production costs at Roan and N'Kana should not differ materially. Indeed, the writer assumes that they will be to all intents and purposes identical. He has had an opportunity of going fully into the detailed figures of one of these properties and has come to the conclusion that at the present average ruling prices, which are very low for standard copper, no money is being lost even after making full allowances for depreciation and debenture interest. If, on the other hand, the output was increased costs would be still further reduced. It may also be assumed that further operating economies are still probable, but these ought possibly to be cancelled by difficulties not budgeted for—such as timbering, deeper winding, and longer haulages. The latest figures issued to shareholders of the Roan Antelope company were given in the last issue of the MAGAZINE and show all-in costs of £22 8s. 2d. per ton before allowing for depreciation and interest. These last charges came to £225,000 per annum—that is, £5 12s. per ton on the present output. If these two are added together a figure of approximately £28 per ton is arrived at, but if the production could be increased to 50,000 tons a year depreciation and debenture interest would drop to £4 10s. per ton and it is a fair assumption that general overheads will drop 18s., making the total all-in costs £26 per long ton, most of which remains in the country.

It has already been mentioned that the original estimates of cost of production were round about £35 per ton, without making any allowances for depreciation and debenture interest. A very brief experience has falsified these estimates in the right direction, however, and from what has already been said if the producers were able to sell their full output at a price equivalent to their original prime estimated cost and no more they would be making very handsome profits. To make this part of the story complete it should be recorded that the plant is doing better than the engineers' estimate by about 50% and that there has been an improvement on the



SKETCH MAP, SHOWING THE POSITION OF THE NORTHERN RHODESIAN MINES WITH RESPECT TO THE RAILWAY: (1) ROAN ANTELOPE, (2) N'KANA, (3) MUFULIRA, (4) CHAMBISHI, (5) N'CHANGA, (6) BWANA M'KUBWA.

original estimates for each individual operation. This statement is, however, reflected in the all-in costs. It is safe to say that no producer in the United States can touch these figures and this raises very serious issues for that great country, which only a few years ago dictated the price policy for the world.

So far as the author can perceive, Northern Rhodesia has few real rival cheap producers. First come their next-door neighbours, the Union Minière, who, however, have never disclosed costs, but have had profitable side-lines in radium and cobalt. It is a fair assumption that, taking credit for profit from these side-lines, the cost of copper production is possibly not higher than that of the Roan. Next come the two remarkable Canadian companies, the International Nickel and the Noranda Copper, each unique in its way, for neither is primarily a copper producer. It is, of course, the main business of the International Nickel Company, as its name indicates, to produce nickel, but copper and the metals of the platinum group are so intimately associated with the nickel that all three must be produced simultaneously. Noranda started as a copper producer, with gold as a very useful by-product. Canadian gold producers have, however, a very tangible premium, notwithstanding the fact that the country is still nominally on the gold standard, and the Noranda has tended to become a gold mine with copper as a by-product, the smelting capacity of the plant having recently been raised from 1,000 tons per day to 2,000 tons per day. The question of costs of copper production is, therefore, in the case of these two companies very much a matter of book-keeping. However, their combined copper production in ordinary times would not exercise a dominating influence on world prices, but obviously, with gold at a premium and nickel stabilized, they are in a very strong if somewhat unique position.

Then come the Braden and Chuquicamata properties, which, together with the four others already mentioned, must be cited among the only really cheap producers in the world. These mines can, with a fair degree of confidence, be placed in the following order with regard to costs:—

(1) Noranda.
(2) International Nickel.
(3) The Rhodesian Producers.
(4) Braden.
(5) Chuquicamata.
(6) Katanga.

SKETCH MAP, SHOWING POSITION OF THE KANSANSHI MINE WITH RESPECT TO THE RAILWAY AND THE CONGO COPPER AREA.

It will be observed that there is not a United States producer in this list, so that if the foregoing reasoning is correct the Empire, *vis-à-vis* the world, now occupies a dominating position, for Northern Rhodesia without much effort could easily produce, and that at a much lower cost than the present, 250,000 tons a year. In 1931 Canada produced 146,000 short tons and in 1932 120,000 short tons. It should also be noted that all this has come about since the War—indeed really within the past seven or eight years. In 1931 the world's production of copper was 1,500,000 tons, but not all was consumed.

In January, 1929—i.e., a year prior to the Empire Mining and Metallurgical Congress in South Africa—the writer submitted a paper to the Institution of Mining and Metallurgy on "The Possibilities of Reviving Non-Ferrous Metallurgy in Great Britain." He then pointed out that one of the weakest links in our metallurgical armour was the absence of facilities for electrolytic refining of copper in this country. In the course of the discussion which followed it was pointed out by more than one speaker that the reason for this lay in the fact that the Empire had not control of the necessary raw material—blister copper—which was then perfectly true. Everyone, however, knew then that Northern Rhodesia was looming ahead and that Canada was coming on. Much has happened since and the Canadian figures have already been given. Moreover, Canada has now erected her own refineries and she could easily supply the Empire and a large proportion of Europe's requirements from them. That fact, however, is of no use whatever to the Northern Rhodesian producers, for obviously it would be uneconomic to send Rhodesian blister copper to Canada and bring back the refined metal to Europe. Moreover, the Canadian refineries are badly handicapped for getting supplies outside during the winter when the St. Lawrence is closed to shipping. The case for erecting an electrolytic refinery in this country seems, therefore, to be fairly well established, for the power required is low and in any case the necessary bulk power could be purchased just as cheaply here as, say, in the neighbourhood of New York. Some blister coppers, owing to the nature of the impurities, which may be valuable as by-products, simply must be electrolytically refined before the product can be marketed. For others this does not hold and fortunately some of the blister copper of Rhodesia, as experience has clearly shown, belongs to this latter category.

This story is almost at an end. The writer has, when recounting it, endeavoured to eliminate statistics, figures, and even finance as far as possible, but, although he has mentioned the names of Mr. Chester Beatty and Sir Edmund Davis already, he feels that he has done these two men—one of them an American citizen too—very inadequate justice. The Northern Rhodesian copper fields owe their present position to these two men more than to any others.

Another man who has not so far been referred to at all is Sir James Maxwell, whose lamented death only took place a few months after having relinquished his office of Governor of Northern Rhodesia. It was not to be expected that all could see eye to eye with the policy for which he was only partly responsible, for his Government were not masters in their own house, the mineral rights belonging to the Chartered Company. Northern Rhodesia was in essence a native state, for before 1926 the whites were a mere handful. The British Government has always taken its trusteeship for native states very seriously and upon Sir James Maxwell devolved the stewardship and just as he was getting into the saddle an unexpected horde swarmed in from the south, upsetting not only the equanimity of his Government, but making calls upon them which they were in no position to implement. They did the best they could and that was not so bad at all considering that the capital was situated right at the other end of the country.

Little more remains to be said. The Roan and N'Kana have been working for a very short time. Indeed the Roan only started producing concentrates in June, 1931, and N'Kana on December 10 of the same year. Capital expenditure in the case of the former at June last amounted to almost £5,000,000 and in the latter to almost £7,000,000, but these figures are not strictly comparable.

Reference has already been made to the capacity of the plants having exceeded the estimates and the chairman of the Roan at the annual meeting on December 7 last stated that, whereas the concentrating plant had been designed for a capacity of 2,000,000 tons of ore a year, it was actually found to be capable of handling 3,500,000 tons—that is, about 75% in excess of the estimated capacity. Although the Rhokana company has made no similar disclosure, it is more

No. 3 Bore-Hole. Old Native Workings, "C" vein. "D" vein. Old Smelter. Power Plant.
KANSANSHI HILL, FROM THE NORTH, 1930.

than likely that it has had precisely the same experience. These are remarkable facts and, viewing the situation as a whole, the low cost of production ranks as one of the finest mining and metallurgical achievements of the century in the non-ferrous domain. True the plants embodied the very latest ideas both in engineering and metallurgy and great credit is due to the designers, the makers of the plant, and to the operating staffs. Conditions in the early stages were the very reverse of easy—in fact, they were just about as difficult as they well could be. Malaria and blackwater were, if not rampant, very nearly so; transport was extremely difficult and uncertain; labour was only fairly plentiful, but the best classes as a rule do not gravitate to regions where the conditions of living are not of the best and such was the experience of Northern Rhodesia. It was because it was not too plentiful that it was economized from the start. Then came the slump, probably the most difficult period of all, when there had to be ruthless retrenchment, in a country, too, where there are no almshouses and no dole. Now what a transformation! Probably nowhere in the world has money been spent more lavishly to make living conditions not only bearable but even enviable and with abounding success.

It has already been mentioned that the Northern Rhodesian copper field is capable of producing about 250,000 tons of copper per annum and it should be added that this can be accomplished with very little, if any, additional capital expenditure. The Union Minière has produced 140,000 tons in one year and plans are in existence to produce 250,000, but some fresh capital would no doubt be required to bring production up to this figure. The field as a whole is, therefore, capable of producing with little effort 500,000 tons per annum and without amalgamating interests, which is quite impossible from the Belgian Government point of view, for they are very large shareholders in the Union Minière. The effect of this on the world position can be readily realized, but there is no need for further merging of interests. Indeed from every point of view this should be discouraged. Good will and a united front are surely all that is required and with the latter the rest of the world can be faced with equanimity. Nay, world prices could even be settled and stabilized by such a combination.

The author has taken every reasonable step to verify his facts and expresses his indebtedness to the works and addresses of the late Sir Harry Johnston, the late Sir Charles Metcalfe, the late Mr. Leo Weinthal, Sir Robert Williams, Mr. Owen Letcher, and Monsieur Buttgenbach. He would further like to thank innumerable others who prefer for various reasons to remain anonymous.

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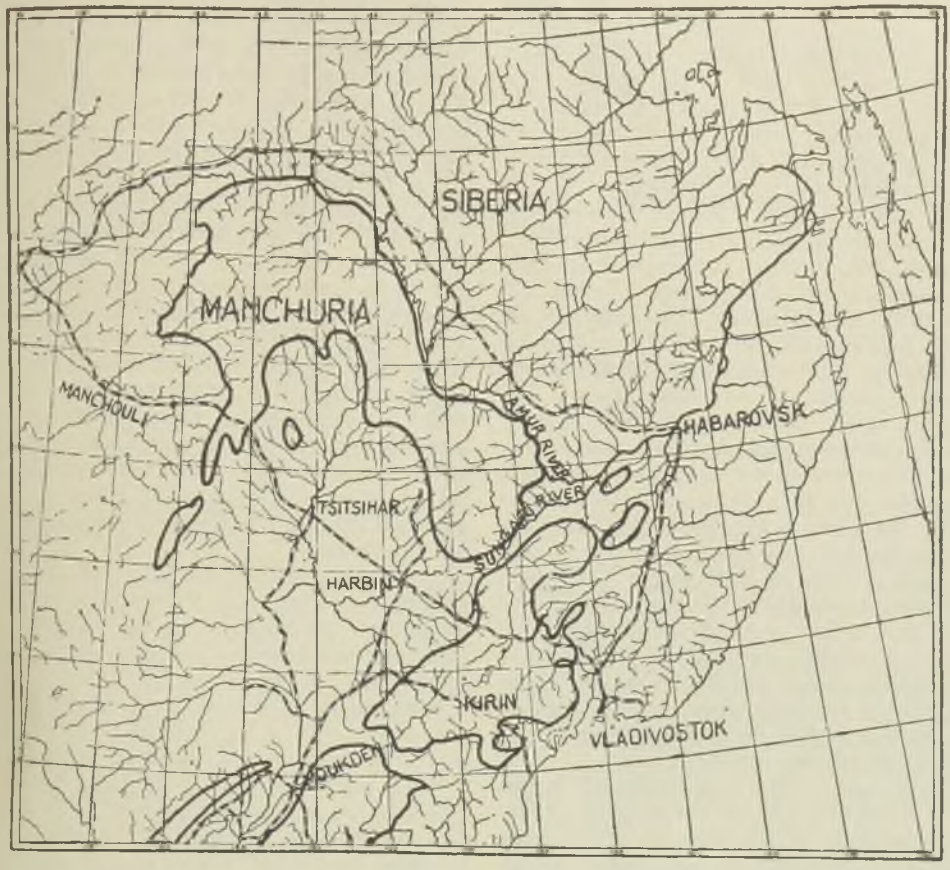
GOLD IN MANCHURIA

By G. T. EVE, A.I.M.M.

The author, who has lately returned from Manchuria and who acts as mining adviser to the Nanking Government, discusses the prospects for alluvial and lode gold mining in that part of Asia.

PLACER DEPOSITS.—The Manchurian goldfields can be roughly divided into two sharply different regions: One is the northern or Heilungchiang gold region, the other is the eastern or Kirin - Mukden gold region. Geologically, as far as rocks which gave birth to the gold deposits are concerned, they are approximately the same. Both areas are composed of gneisses, schists, granites, and porphyries of Palæozoic or pre-Palæozoic age. For the rest these two regions are completely different in every respect. The Heilungchiang region is a continuation of the Zeya-Selemdja-Bureia gold-bearing belt and it possesses the same characteristics climatically and historically, while the great enemies of the alluvial gold miner—perpetually frozen ground and severe climatic conditions—are present.

Notwithstanding the great age of the gold-bearing rocks and their exposure to atmospheric agencies, the gold-bearing alluvials are of comparatively recent formation. In most cases the gold deposits cannot even be called "alluvials"—they are of eluvial type and the greater part of the gold obtained in these districts belongs undoubtedly to that type of formation, gold of a rather coarse and heavy variety being found in comparatively narrow and shallow (15 ft. to 25 ft.) pay streaks on or near the rock which gave it birth. It is usually found in creeks or creek-beds and, on leaving the belt of gold-bearing rocks, it diminishes rapidly in quantity and size and, after a short tail, passes into a state of finely and very widely dispersed dust. What happened to the older alluvials—which were undoubtedly of great volume, with a corresponding quantity and concentration of gold included in them—is not known. In some cases they may still lie hidden under a covering of basaltic lavas or glacial moraines, which have preserved them from erosion, but there is no direct evidence on



SKETCH MAP, SHOWING THE AURIFEROUS DISTRICTS OF MANCHURIA (AFTER PROFESSOR E. AHNERT).[1]

the matter and only the shallow and rather erratic deposits of eluvial or semi-eluvial type can be discussed.

Under favourable conditions these deposits are grouped together in more or less large systems, some, like the Mo-ho, Albasiha, and Fabira, being of spectacular value, and certainly the intensity of concentration of gold in some of them was great, running into many dollars per cubic yard, but nowhere was the total quantity found to be of any considerable bulk, which, of course, is quite usual for this type of deposit. Generally the deposits are found in the upper reaches of creeks of comparatively small gradient which do not carry any great amount of water, hence their eluvial type. In the majority of cases the ground is perpetually frozen, or, at best, consisting of patchy ground, where thawed and frozen are mixed without any apparent order or rule.

In nearly all of these deposits the amount of water present is not too great to interfere with mining by hand labour. The only thing likely to interfere with such a mode of operation would be when an excessive amount of water is encountered, but such conditions are seldom met with in the creeks, although they may occur in the larger valleys, where, except occasionally, the gold is dispersed in the form of a fine dust over an area so large that it becomes unprofitable to mine.

The northern part of the Kirin Province, with its streams flowing into the Sungari River on one side and into the Sea of Japan on the other, forms a transition stage, so to speak, between two extremes—i.e., Heilungchiang and Kirin. There is reliable information to hand that in this district large and deep gold placers do exist. Frozen ground is absent and the gold occurs in shallow

[1] From the *Far Eastern Review*, July, 1932.

creek formations, bench placers, and large valley placers, particularly in the Mutanchiang and Mulinho system of rivers. Their comparative proximity to the railway, the abundance of timber, and the numerous outcrops of coal, some of which are already exploited, make this district most attractive and promising for placer mining.

The policy of the Chinese Government practically closed this district for gold-mining ventures. Illicit miners and small companies, with the help of local Chinese officials, did work there, but only on a small scale and on those creek deposits which did not demand large capital or the employment of machinery. A large percentage of such placers has probably been worked out, but reliable statistics are not available. Drilling operations undertaken by Russian concessionnaires before the War and before they were driven out by the Chinese Government show that in this district conditions were favourable for the deposition of gold and it is thought to be present in workable quantities in the larger and deeper valley deposits. The drill records available and the comparatively mild climate and proximity to the sea make this district an outstanding one as regards possibilities of the future development of gold placer mining in Manchuria.

The placers of the Upper Sungari proper (Kirin Province) and of the streams of the north-east part of Moukden Province were worked for centuries in the past. Owing to the steeper grade and sharp seasonal fluctuations in the water levels they were easier to be exploited by hand labour, but, as far as the object of this article is concerned, they are of very slight interest, for the simple reason that they have nearly all been completely worked out. It is true that there is still a chance of finding low-grade placers buried in the large river valleys or ancient deposits concealed by blankets of basalt, but, owing to the absence of a proper geological and mining survey of the area in question, all that can be done is to leave the problem open until political and financial conditions favour prospecting once more, for the factor of a chance discovery is always present.

From the evidence available it may be deduced that from the point of view of practical mining the following conditions are present in this part of the world:—The Heilungchiang Province placers are adaptable to such hand-working methods as will entail a comparatively small outlay of capital, but a cumbersome administration would probably be necessary for such work and the complete demoralization of local employees and men would have to be taken seriously into account, for a large number of men would have to be employed, and it is probable a considerable amount of gold would be stolen. The Northern Kirin Province placers, on the other hand, offer a comparatively excellent chance for large-scale mining with the employment of machinery, where the control of the gold can be properly organized, where the number of employees and men would be much smaller, and the volume of gold won much greater, but where the capital invested would be considerably larger than in the first case. On the other hand, the North Kirin placers, having already been prospected, at least partially, and prospected with favourable results, the factor of safety for capital invested there is much greater than in any other district of Manchuria.

Lode Deposits.—The gold-bearing reefs of the Heilungchiang Province are known so far only by negative results. Nowhere in this province was any primary gold deposit found, at least not of payable quality. It is a remarkable fact that to a larger extent the same rule is applicable to the Zeya-Selemdja belt on the Russian side of the Amur, where only two payable primary gold deposits are known to exist. The writer has visited each of them and in both cases he came to the conclusion that strong local secondary enrichment took place, an enrichment which is bound to disappear on reaching the ground water level.

As regards the northern part of the Kirin Province, there are numerous reports on hand indicating the presence of possible primary gold deposits. There is no reason to believe or to disbelieve these reports, but it is noticeable, nevertheless, that no such reports —at least, reliable ones — are forthcoming from the Heilungchiang Province. From further south, however, in the Kirin Province proper, there are not only reports of outcrops, but also about working mines or mines that have been worked. According to these accounts a gold-bearing belt stretches across the Upper Sungari region, a belt composed mostly of gneisses and crystalline schists, with a general north-east strike, with quartz veins intersecting or running parallel to the general strike of the neighbouring rocks. Some outcrops of these veins were worked out (the famous Chia-p'i-kou mine, for instance) in ancient times,

presumably to the ground water level (the old workings are flooded out at present), but the samples taken from the remaining pillars give surprisingly high values of gold—up to $28–30 per metric ton of ore. Numerous other outcrops are reported from the same region and, considering the Chinese mining technique of ancient times, it is safe to say that the district in question is the most promising, in so far as gold reef mining is concerned, of the whole known Manchurian goldfields.

The writer spent most of 1931–2 in North Manchuria studying local conditions and gold-mining prospects and left that promising field most reluctantly, but in his judgment the existing political conditions are such as to render the employment of foreign capital inadvisable at the present time.

THE ROTARY PAN FOR DIAMOND CONCENTRATION

By J. SIM, B.Sc., A.I.M.M.

The author discusses the action of the rotary pan for diamond concentration, examining in particular the means by which concentration is effected.

Search of the available literature does not disclose much writing on the rotary machine used in diamond concentration. Recently Walker (1) [1] has contributed his views. Further reference is made by Wagner (2), by Williams (3), by Draper (4), by Eulich (5), and by Williams and Harbottle (6). The operation of the pan has been described in all these articles with, perhaps, the exception of (4). There is, therefore, no necessity to do so here. The question to be decided is how the concentration is effected.

The fluid, or puddle, may be assumed as rotating with constant angular velocity and its free surface to be a paraboloid of revolution. Surfaces of equal pressure in the fluid are also of this form. If the effect of smooth entry and quiet overflow be such as to permit their neglect in this discussion, the matter is simply one of forced vortex motion. Separation of immiscible liquids is effected by such motion. The surfaces of separation assume the form just mentioned.

The path of a body falling in a rotating fluid is a slightly complicated one and its mathematical consideration does not arise here. It is easy, however, to show that gravitational lines in forced vortex motion are logarithmic curves and it is possible to imagine a surface formed by rotating one such curve round the axis passing through the vortex centre. A descending spiral on a surface of this kind is probably a fair approximation to the path of a body falling in a rotating fluid.

It is an accepted principle of classification according to settling rates in a current of water moving horizontally that mineral grains will fall at different places along the bed of the stream, but that the grains which fall at one place have been deposited there according to a particular law.

The problem under consideration is a much more complicated one, however. It could not be examined from such an angle and in any case the stirring action of the tynes adds an additional difficulty to the ultimate solution. It is, however, open to another method of analysis.

In order to gain efficient gravity concentration it is agreed that effective stratification is necessary. Such a state obtains when all the dense grains lie on the bottom, the smaller ones finding their way there by falling between larger and less dense ones. There are a number of conditions necessary to effective stratification, but one of them is mobility of the bed, and the constant stirring action of the tynes gives this in the diamond pan. Centrifugal force is freely stated as playing a part, but it cannot be a very important one at the rotational speed of the fluid.

In centrifugal separation high rotational speeds are employed. Centrifugal force only affects the terminal settling velocity. The difference between gravity and centrifugal concentration is best exemplified in the ancient and modern problem of the cream on the milk.

The path of a body falling in a rotating fluid has already been dealt with. It must be agreed that the part played by centrifugal force is small and it is difficult to depart

[1] The figures in parentheses refer to the bibliography given at the end of this article.

from the opinion that this is purely a case of gravity concentration. In other words the machine is no other than a glorified gold pan. The consistency of the puddle increases, of course, the ratio of the specific gravities of the minerals to be concentrated, but it plays another part. Through its viscosity it imparts stability to the forced vortex motion and the path of the falling grains is steadier.

Walker (1) states that the pan can be compared to a V-shaped sluice of infinite length. His reasoning that, if the angular velocity of any particle in the pan be so low that the C.F. acting on it is less than 0·0067 lb. per cu. in., the particle will be driven towards the centre is difficult to agree with. It is correct to state that a body will rise through water when the downward force of gravity is less than the upward force of water provided no other forces act on the body. It is not, therefore, reasonable to argue that a body will drift towards the centre of the pan when its C.F. falls below a certain figure, because there are other forces to be considered.

Eulich (5) states that the concentration can be effected without special setting of the tynes. He is, doubtless, correct in this, but, as the tynes have the function of stirring up and prolonging the falling spiral path of the mineral grains, their setting must have an effect on the efficiency and time of concentration.

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LETTER TO THE EDITOR

Average Width of Ore-Bodies

SIR,—On p. 522 of the 1929-1930 volume of the *Transactions* of the Institution of Mining and Metallurgy Professor Watermeyer discusses the following alternative methods of computing the average width of ore mined :—

METHOD A		METHOD B	
Tons	*Width*	*Tons*	*Width*
3,000 × 36 =	108,000	3,000 ÷ 36 =	82·4
5,000 × 30 =	150,000	5,000 ÷ 30 =	166·7
6,000 × 45 =	270,000	6,000 ÷ 45 =	133·3
9,000 × 50 =	450,000	9,000 ÷ 50 =	180·0
7,000 × 60 =	420,000	7,000 ÷ 60 =	116·7
8,000 × 48 =	384,000	8,000 ÷ 48 =	166·7
38,000	1,782,000	38,000	845·8
$\frac{1,782,000}{38,000}$ = 46·9 in.		$\frac{38,000}{845·8}$ = 45 in.	

Concerning Method A, he says: "This is quite a plausible method of arriving at a result, but is it sound? The method employed at the present day consists in dividing each tonnage by the corresponding width and obtaining a figure proportionate to the area excavated. The sum of the tonnages divided by the sum of these figures proportionate to the areas concerned should give the most probable mean width." That is to say, he prefers Method B.

Now my conception of the mean width is that which fulfils the condition that if any tonnage of that width were added to the original tonnage, or subtracted from it, it would not affect the final average. Apart from trifling approximations in the above figures, which are as he gave them, only Method A satisfies this requirement. Additional interest attaches to the problem at the present moment, because Dr. John S. Owens, in a paper on "The Power used in Crushing Ore," which he has just read before the Institution, uses a method of computing the mean diameter of a crushed product which is analogous to B, while the commonly used method is that of A.

R. T. HANCOCK.

Camborne.
March 22.

BOOK REVIEWS

Mine Examination and Valuation. By CHARLES H. BAXTER and ROLAND D. PARKS. Cloth, octavo, 316 pages, illustrated. Price $3·00. Houghton, Michigan: Michigan College of Mining and Technology.

In one respect, at any rate, this work covers more ground than its title would indicate; it does not confine itself to mines,

but also covers mineral properties which may in due course blossom forth into mines, though they may not have reached that stage as yet. In some respects this is quite a good book, but unfortunately it will prove of relatively little use to British readers, because the authors appear to be but imperfectly acquainted with British literature of the subject and indeed with British mining as a whole. Had their studies under the former head been more complete they would surely not have stated in their preface that none of the books on the principles of valuation includes " a discussion of the examination " of mineral properties. Surely every complete work on the valuation of such properties must include an account of their examination—i.e., of the collection of the data upon which the valuation must be based. Moreover, on p. 88, the definition of " ore in sight " adopted by the Institution of Mining and Metallurgy ought to be at least referred to by anyone familiar with the British literature of the subject. Again, whilst the book commences, as it should do, with certain definitions, these are by no means inclusive enough and the definition there given of the term " mine "—namely, " any artificial excavation made for the purposes of winning mineral values "—is correct in the United States, but incorrect for Great Britain, because it would include quarries, which are not classed as mines in this country. Another non-British view is to be found on p. 4, where the authors discriminate between sellers' and purchasers' reports. An honest valuer will pay no attention to the fact whether he is retained by the seller or the purchaser, but will put an honest value on the mineral property, quite independently of the interests of the parties by whom he is retained, and then will leave the seller and purchaser to make their bargain as best they can, using his valuation, of course, as a starting point, but only as a starting point for arguing out their respective interests.

Naturally one of the most important sections of mine examination refers to sampling, but we are rather surprised to find that the authors confine their method of cutting a sample to hand work and do not even suggest the use of the compressed air hammer-drill for this purpose, although it has been largely and successfully used in hard rock. Furthermore, they leave the question of the reduction of the first sample to manageable dimensions quite untouched, although this question is one which presents numerous problems. Whilst a good many pages are given up to the discussion of bore-hole samples and their spacing, no reference is made to the very full discussions of this subject which have appeared in the *Transactions* of the Institution of Mining and Metallurgy.[1] The thorny question of the treatment of abnormal assays is very imperfectly dealt with. The authors give no real method for dealing with these, but only say that " it is a problem which requires keen judgment " ; they do not seem to be aware that there is a mathematical method of dealing with this difficulty, such as that given by David Brunt in his book " The Combination of Observations." A rather similar weakness of the authors, inasmuch as they do not appear to see the mathematical basis for their work, is to be found in their method of dealing with lack of uniformity ; they cannot apparently suggest any better method than that of " subtracting a percentage of the final computed tonnage figure " ; they do not base this percentage, as they should do, upon the probable error as defined by mathematicians.

At the same time there is much of use in the book, and especially in the authors' treatment of other mine-valuation formulas than the one which they have adopted. It is especially interesting to note their treatment of the Morkill and Grimes-Craigue formulas ; both these are based on the principle that a risk rate—or, as Grimes and Craigue call it, " a speculative rate "—should not be received by the investor upon the whole of the original capital throughout the life of the mine, because portions of this capital are being theoretically returned or at any rate removed from risk. There is a great deal to be said for these contentions, but all these writers (including the authors of the present book) seem to overlook the fact that " he who pays the piper calls the tune " and that investors are entitled to say that they will not put money into a mining proposition unless they receive a specially high rate of interest during the whole life of the mine, irrespective of whether theorists consider this to be an equitable arrangement or not. As valuation deals not with theories, but with existing principles and ideas, the investors' point of view must necessarily prevail. The book concludes with a number

[1] *Trans.* I.M.M., vol. xxxvii, p. 437, and *Bull.* I.M.M., April-August, 1932.

of tables to facilitate calculations, but these tables only deal with the more common rates of interest and thus would incline a valuer to use an approximate rate that he finds in these tables rather than a correct rate derived from a consideration of the known facts. For example, money accumulating at $4\frac{1}{2}\%$ less income tax at 5s. in the pound really accumulates at 3·375%, and, rather than working this out as a valuer should do by logarithms, he might with this book before him be inclined to use only the 3% or possibly the 4% table. It is distinctly better in a book of this kind not to give any tables at all, but to give formulas arranged for logarithmic computation, which after all takes very little more time than consulting tables, whilst the work involved is infinitesimal compared with that of collecting the data by a proper examination of the mineral property. Finally British readers must be warned that throughout the book they will find not a single reference to the incidence of income tax, which at the present high rate is a very serious matter and, as we all know, handicaps gravely the British mine speculator as against operators in other countries.

HENRY LOUIS.

Miami-Picher Zinc-Lead District. By SAMUEL WEIDMAN. Cloth, octavo, 177 pages, illustrated. Price $2·50. Norman: University of Oklahoma Press.

This book has a far wider interest to mining geologists and mining engineers than a detailed and clear description of the Miami-Picher zinc-lead deposits, for this district, located in Ottawa County, in the north-eastern corner of Oklahoma, is the most important part of a much larger mining area extending north into Kansas and north-east into Missouri, forming that most remarkable metallogenetic lead-zinc province of the Tri-State district familiar to most readers as the "Joplin region." The Tri-State field has been for the last 50 years and still is the most important zinc-producing region in the world, averaging for the last 10 years between 300,000 and 400,000 tons of zinc a year, or about 70% of the total U.S.A. production and over a third of that of the world. It yields also about 15% of the U.S.A. lead production. The field is of particular interest, however, not only because of its immense production but also because of the supremely important controversies, in which the leading mining geologists of the United States have from time to time taken part, that have centred round the genesis of these deposits. The descensionists claim that the ores were deposited by descending atmospheric waters; the ascensionists, by ascending atmospheric waters during their circulation, both schools being in agreement that, as no igneous rocks were then known in these areas, magmatic waters played no part as mineralizing solutions, and Bastin invoked the aid of anaerobic bacteria in the precipitation of the sulphides. Jenney and Nason, however, believe that thermal waters ascended from depth and that the source of the ore was deep-seated and Tarr, Pirsson, and Spurr hold the view that the mineralizing solutions were of magmatic origin.

The author, as the result of considerable field-work during parts of 1927 to 1930, considers the various theories of origin in detail and points out that evidences of the presence in many parts of the field of Post-Carboniferous granites and granitic rocks is gradually increasing. In 1930, for example, granite was struck in a well in the Bird Dog mine, near Picher, at about 600 ft. above the general level of the Pre-Cambrian granite floor of the district. He has come to the conclusion that the ore is of magmatic origin, but not in direct contact with the igneous rocks from which it is derived, thus being in agreement with Spurr, Tarr, Pirsson, Graton, and others.

The author has made a very valuable contribution to our knowledge of the genesis of the ore-deposits in this world-famous field, long considered by some authorities as the classic area where atmospheric, and not magmatic, waters were the mineralizing agent. It is intriguing to consider how many mineralized areas remain where later developments have not supplied important data in support of deposition by magmatic waters, as against previously held theories of deposition by circulating atmospheric waters.

WILLIAM R. JONES.

Geologische Karte Der Erde. Lieferung 3. Blatter 7, 8, 11, and 12. Scale $\frac{1}{15,000,000}$. Price, for the complete map, RM. 240. Berlin: Gebrüder Borntraeger, 1932.

The first and second parts of Beyschlag's geological map of the world have already been reviewed in the MAGAZINE (June, 1930,

p. 355, and November, 1930, p. 282). The third part, now issued, completes the map and includes most of Africa, India, the East Indies, Australasia, and the remaining part of Antarctica. An additional sheet gives the colour index and list of symbols, and it now appears that the symbol Pk which appeared on the map of South America on patches of different colours stands for Palæozoic metamorphic rocks. Part of the same sheet gives a corrected map of a portion of East Asia, to be cut out and pasted into its proper place, and a similar correction for the Fiji Islands.

The map is naturally by far the best of its kind that has yet been possible, but no less naturally it is of a kind that requires constant revision as the less-known regions come under geological exploration and survey. Indeed, already one can see that the last sheets to be published would have benefited very considerably had the recently-issued geological maps of South-Equatorial Africa (African Geological Surveys) and Australia (Sir Edgeworth David) been available. Comparison of these maps with the Beyschlag map brings out many striking differences in detail and interpretation. Nevertheless a geological map of the world is invaluable for certain purposes and this one will make two attractive wall-maps to adorn the geological lecture-rooms of those institutions that can afford the distinctly unattractive price. The colouring is clear and transparent and has been well designed to bring out the salient structural features. Rivers and lettering are perfectly clear and the registration of colours and boundaries is so faultless that a surprising amount of detail has been shown without danger of confusion or eye-strain.

While the map as a whole is a most welcome contribution and one for which Dr. Beyschlag and his collaborators deserve gratitude and sincere congratulations, the price, as indicated above, is far from welcome in these days of economy and adverse exchanges. It is difficult to see what justification there can be for charging a price which will effectively limit the sale almost to vanishing-point. It would seem indisputable that at half the figure far more than twice the total number of copies would have been sold and the publishers should seriously consider the practicability of making their map more generally available. The subscription price was 150 marks and it is unlikely that those who could not afford to subscribe two years ago will be able to spend 240 marks now.

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

NEWS LETTERS

BRISBANE

February 27.

Mount Isa.—Mr. J. P. B. Webster, director of Mount Isa Mines, Ltd., and of Mining Trust, Ltd., before leaving on his return to London gave a further assurance that every endeavour will be made to keep the Mount Isa mine in operation, notwithstanding the continued abnormally low price of lead. This assurance is supported by a promise from Ministers of the Crown that the State Government will assist the company in any reasonable way possible. The Government as well as the company is seriously concerned in keeping the Mount Isa enterprise going, not only on account of the large number of men who would be put out of work by a stoppage and of the loss of traffic to the railways that would result, but also by the fact that about £50,000 of public money is being spent on coke ovens at Bowen, in order that coke as well as coal may be supplied to the Mount Isa mine. The output of coke from these ovens, which are approaching completion, will for Mount Isa alone amount to 24,000 tons yearly.

Details of Mount Isa Ore.—In the following table are given details of the January output of the Mount Isa mine, compared with those for December, 1932—

	Dec., 1932.	Jan., 1933.
Ore mined, tons	63,107	73,846
Ore milled, tons	63,000	75,584
Assaying—		
Lead, per cent	10·9	10·3
Silver, oz.	5·4	5·1
Lead concentrates produced :—		
Flotation, tons	11,368	11,573
Assaying—		
Lead, per cent	42·4	43·1
Silver, oz.	18·7	18·8
Jig tons	1,044	1,983
Assaying—		
Lead, per cent	49·1	49·9
Silver, oz.	21·9	21·0
Silver-lead bullion produced, tons	4,544	5,654

New Queensland Goldfields.—Energetic prospecting and development work is being

carried out by several strong companies on the new Cracow goldfield, in Central Queensland. A report for seven of these companies by Dr. Loftus Hill, formerly director of the Geological Survey of Tasmania, states there is ample justification for believing that the Cracow lode system will live to depths comparable with those of the more productive goldfields of Australia. He affirms that the field possesses all the essential characteristics of an important goldfield. Moreover, the geologist's investigation has elicited the fundamental factors controlling the formation of the lode system as well as the deposition and distribution of gold values and he states that work based on these conclusions will result in a closer estimate than is now possible of the potential gold output of the new Cracow field. It is also affirmed that, while the field is only in the prospecting stage, there is every justification to push on actively and confidently with work on the main lode system. Another goldfield, more recently discovered, is at Hawkwood, also in the Central district. Here several leases have been taken in hand by a company with a capital of £50,000. The work done so far has shown a great length of mineralized country carrying at least one rich shoot of ore capable of being worked with profit and with possibilities of other similarly rich shoots both abreast of and in line with it along the strike. The full length of this shoot has not yet been proved below the ground and, according to Mr. W. E. Cameron, geologist, the possibility of finding other shoots both along and across the line of strike offer good prospects of success with further development. Two prospectors have likewise found gold near old diggings on a field known as Cania, also in the Central district. The principal leases on the comparatively new goldfield on North Arm, near Gympie, together with battery, mining plant, etc., have been placed under option of purchase by a company for £45,000.

Mount Morgan.—The Mount Morgan mine and works are now daily treating up to 200 tons of stone from the open-cut. The district inspector of mines reports that the results are favourable. With a view to treating 500 tons of stone a day, or over, the power, grinding, and flotation plants are being increased in number and the old ones renovated.

Lolworth Creek Gold.—Operations at the newly opened up Lolworth goldfield, in the Charters Towers district, Queensland, are being watched with some interest. After a delay for want of water, the battery, erected on the field began crushing on January 4 and, with the exception of two or three slight delays for adjustments, continued operating during the month. A total quantity of 163 tons of ore was crushed for a yield of 48 oz. 17 dwt. of gold. It is intended to work three shifts at the mill while enough stone is available and there is a large quantity waiting for treatment on the surface at the various mines. The extraction results at the mill have given every satisfaction and further rains during January have afforded an ample water supply for some time.

Bendigo Goldfield. — The revived interest in the historical Bendigo goldfield, Victoria, is increasing. A suggestion that a mining development committee be formed to assist the mining industry on the field is being widely supported. It is generally recognized that its potentialities are great. When the mines closed down in 1924 many people feared that they had been worked out, yet eight years later one mine (the Hercules) produced in six months more than 8,000 oz. of gold. On a production of 7,314 oz. of gold from 3,668 tons of ore in the half-year ended December 31, 1932, the Hercules Gold Mining Company, N.L., earned a net profit of £39,812, out of which it paid £21,000 in dividends and placed £7,000 in reserve. Since the end of the term £12,000 more has been distributed to shareholders and a further payment of £12,000 was made on February 17. The company has a credit balance of £18,665 in addition to the reserve fund of £7,000. The directors state that the outlook for some considerable time to come is very good.

Tasmanian Asbestos.—The property of the Tasmanian Asbestos Mining Company, N.L., has been increased from 80 to 160 acres and the estimated reserves of asbestos-bearing stone and terrazzo rock have been nearly doubled. Crushing has begun and the first consignment of asbestos has been delivered in Melbourne. Negotiations have been proceeding with firms in the United States and Canada for the production and marketing of asbestos fibre on a large scale. Samples of terrazzo rock have been sent to London.

B.H.P.'s Gold Mine.—The Broken Hill Proprietary, Ltd., in pursuing its policy of acquiring gold properties, recently

exercised an option over the Hannan's North Extended mine, Western Australia. On this property a treatment plant, with a capacity of 1,200 tons of ore a month, is now being erected.

Rare Mineral Discovered.—Some time ago a prospector, Mr. J. Wallace, working on a section near the North-East Dundas tramway, on the west coast of Tasmania, discovered a mineral that had not previously been located in Australia, but which he thought was nickel-bearing. The mineral has been determined as gersdorfite, a sulpharsenide of nickel, new to Australian mining.

IPOH

March 16.

Restriction.—The authorities controlling the operation of the Tin and Tin Ore Restriction Enactment F.M.S. have just announced that there is to be a temporary additional cut of 2% on all producers during the second quarter of this year—April to June inclusive. In a circular dated March 8 it is explained that the standard quota issued on the adoption of the amended Byrne Scheme was locally in excess of the true figure, which should have been 24·4% instead of 25%. This circular, which is signed by the Warden of Mines, contains the statement that "miners have produced in full up to the limit of their quotas and there has consequently been no saving." It is a fact known to everyone closely concerned with the industry, however, that there are a number of dormant assessments on which there has never been any production and there have also been for various reasons reductions in previously approved assessments. It is not too much to say that in the last year the administration of the restriction enactment in these States has had unfair and vexatious results, discouraging endeavours to keep producing mines open and making it often much more profitable to sell the quota than to work a mine. The policy followed has also assisted parasitic interests to interfere oppressively with the work of genuine producers. It will be remembered that it was by the consent of actual producers mainly that the policy of restriction was accepted for this country and the retention in employment of as much skilled or habituated labour as possible was a declared object in the scheme submitted for acceptance. There is now in Perak a very widespread opinion that the sooner restriction as now applied can be removed the better for most genuine producers.

In the circular above referred to much is made of the small margin of over-production by this country, in which restriction of output is most rigorously enforced. At the same time there are increasing supplies of tin ore from countries not under any form of restriction and among those which are under obligation to restrict Bolivia has exported more than a thousand tons above its quota. Further, it is only reasonable to ask whether stocks may be accumulating there, and possibly elsewhere also, which would cause heavy over-supply of the market at any time on their release. The productive capacity of the Belgian Congo is another factor in a situation which is becoming more and more unsatisfactory for producers in this country. A period of cheap labour and generally low costs is an excellent time for undertaking development and reorganization and the Government should encourage all genuine proposals aiming at efficiency and should give special consideration to mines which aim at improving their value and earning capacity, for the industry is such a very important source of income, directly and indirectly, both to this country and to the United Kingdom that non-productive financial interests on the one hand and lack of vision and administrative capacity on the other must not be allowed to increase its present difficulties or to prejudice its future in competition with the rest of the world.

JOHANNESBURG

March 2.

South-West Rand Extension.—It is stated that options have been taken over many more farms lying along the line of the south-western extension of the Witwatersrand Main Reef Series beyond the very large area secured by the New Consolidated Gold Fields for the West Witwatersrand Areas, Ltd., and that there is great prospecting activity between Potchefstroom and Klerksdorp and onwards to the Vaal River. Rand mining houses and a French syndicate are said to have acquired many options along this new line. It has been pointed out in the local Press that apart from the locating of the Main Reef horizon along the West Witwatersrand Areas' section a not unim-

portant result of the present investigations will be the light that will probably be thrown upon the geological character of the reefs compared with that of the conglomerate bodies in the neighbourhood of Randfontein. Inasmuch as distinct changes occur in the reef ensemble, as it may be termed, and in the peculiarities of the individual beds, it is quite natural to expect that some more or less local features will be found to be associated with the long stretch of country beyond Gemsbokfontein. Some indication of such a change was suggested by the texture of the quartzite and the quality and distribution of the pebbles in No. 9 bore-hole that was put down on the farm Libanon some 25 years ago and which was the last and most southerly of all those drilled at that time. It is, however, not possible to form any reliable conclusions with regard to a question of this kind from the data of any single core. Only a series of drillings can be expected to show such changes as those that are in evidence over various sections of the Witwatersrand. The bore-holes are, of course, merely a preliminary investigation in order to provide justification for more detailed work and if they achieve little more than a precise locating of the reef horizons in depth they will have accomplished all that can reasonably be required of them. Although the physical condition of the reefs may show local or regional variations from, say, the nearest exposures around Randfontein, there is no reason to suppose that the persistent gold-bearing quality of the ore-bodies will be materially affected.

Longer Life for Rand.—Chamber of Mines statistics for January show that the gold-mining industry has lost no time in putting into effect its declared policy of milling larger quantities of lower-grade ore. The average grade last month was reduced by 0·2 dwt. compared with the December figure. A further average reduction is anticipated for February and subsequently, as it proves feasible, it is intended more generally to give practical effect to the agreed policy of utilizing the opportunity afforded by the increased price of gold to exploit ore of lower grade and extend the scope and life of the industry. While the ore milled by Transvaal producers in January was 57,000 tons greater than that returned for the preceding month, the total output shows a decrease of 13,161 oz., due to the yield per ton having fallen from 6·486 dwt. to 6·285 dwt. At £6 per oz. the working revenue represents an increase of £1,599,170 on the figure for December, when there was no gold premium.

Another New Goldfield.—A strong prospecting company has been formed in Johannesburg for the purpose of prospecting a string of farms in the Wolmaransstad and Lichtenburg districts, Western Transvaal, where the formation resembles that of the Witwatersrand, according to a report made by Dr. G. A. F. Molengraaf, the former State Geologist of the old South African Republic, some 30 years ago. Dr. Molengraaf stated in the report that in the block of 20 odd farms examined by him " the properties offer big possibilities and may give a new and unexpected extension to the gold-bearing area of the Transvaal." Strange to say the report has in effect remained " lost " for exactly 30 years (it was issued in January, 1903) and not until the present excitement and enterprise in the gold industry were manifest did the matter again receive attention. Dr. Molengraaf, who was assisted by Dr. Krause, another eminent geologist of that time, was further confirmed in his findings by the investigation of another prominent old-time authority, Mr. E. G. Woodford, formerly State Mining Engineer to the Kruger Government. In 1905, while in private practice, Mr. Woodford visited the Wolmaransstad and Lichtenburg neighbourhood in question and pointed out that " prospecting operations may possibly uncover a new ' Rand.' "

World's Deepest Gold Mine.—The deepest point in the Turf (old Village Deep) section of the Robinson Deep (the world's deepest gold mine) now exceeds 8,000 ft. below the collar of the shaft. The programme which has been laid down for this part of the mine will entail working at a depth of 8,500 ft. and no extreme changes in present methods are anticipated in carrying it out. In the Turf section depletion takes place at the rate of approximately 200 ft. vertically per annum. Using this figure it is estimated that an additional 2,000 ft. vertical advance in depth represents a possible increase of ten years in life. It is believed that it will be possible to work to a depth of 10,000 ft. To mine at this depth it may be necessary to introduce special methods, such as the sinking of deep vertical shafts, further provision for the support of workings, and the conditioning of the mine air by means of refrigeration and dehumidification.

Mineral Right in Rhodesia.—A message from Bulawayo says that an important

statement relative to the Southern Rhodesian Government's claim to the ownership of the mineral rights of the colony has been made by the Attorney-General. A non-party committee of members of the Legislative Assembly had recommended that counsel's opinions be taken here, in the Union of South Africa, and in England. The Attorney-General stated that, while counsel's opinion in Rhodesia was favourable to the Government's claim, opinion in the Union was adverse. The Imperial Government had been asked to consent to the claim going direct to the Privy Council, but this the Imperial Government had emphatically declined to allow. The position was complicated by the case in which Sir Hugh Williams was being sued by the British South Africa Company and, in view of this being sub judice, it was impossible for the Government to publish the terms of the Imperial Government's dispatch or the text of the opinion of counsel in the Union. The opinion of British counsel was still being awaited.

VANCOUVER

March 10.

Cariboo.—In a progress report dealing with the operations of his company Fred. M. Wells, general manager of Cariboo Gold Quartz Mines, Ltd., stated recently that during the latter stages of the initial period of milling that was entered upon in the beginning of January the cyanide plant was handling 40 tons per day and that a satisfactory recovery was being made. Mr. Wells expresses the opinion that the ultimate prospects of the company are in relation to large-scale operation on ore of low grade, rather than to selective mining of the higher-grade content of the "B" series of cross veins alone. The plan of development outlined embraces an intricate system of cross-driving on the "B" vein series to connect with the second shear, in which the major possibilities are to be seen, together with parallel development, in the expectation of opening up similar successions of ore-shoots. Further development by shaft-sinking is a natural proposition in view of the promise of persistence that is implied. The continuance of the main cross-cut to reach the primary objective represented by the attractive surface showings on the Rainbow claim is understood to be the immediate purpose of the management. Active development has been commenced by Cariboo Consolidated Mines, Ltd., upon the properties acquired from Reward Mining Company on Island and Proserpine mountains. On Island mountain a 2,000-ft. cross-cut tunnel is being driven and on the Proserpine mountain property, covering the old Forrest mine, where old shaft workings had been carried to a depth of about 70 ft. below surface, a tunnel has been commenced that is expected to intercept the downward continuation of a promising "B" vein in a distance of 400 ft. This work was started after the old workings were unwatered and an examination had disclosed attractive features of sulphide mineralization. A group of 24 claims covering the old Foster mine on Chisholm Creek has been acquired by the Bridge River Exploration Company. This property represents one of the oldest locations in the camp and was referred to in a report of the Minister of Mines for the year 1877. It is understood that a geological reconnaissance of this newly-acquired property, situated some two miles from the Burns Mountain group, will be made as soon as the snow is off the ground. Interests connected with Bralorne Mines, Ltd., are said to have acquired an option on another group of eight claims near Stanley, including the old Montgomery property, from which in the early days of lode mining in the camp an amount of 600 oz. of gold is reported to have been washed from the "rotten" outcrop of a vein. The United States Smelting and Refining Company is reported to have acquired an option on about 50 claims in the south-east section of the Barkerville area, covering some attractive prospects, including new discoveries, on Nugget mountain, between Antler and Cunningham creeks.

Bridge River.—Encouraging reports are received of recent developments at the Pioneer mine, where lateral developments have proved the extension of the main vein beyond points at which it was thought previously to have pinched out. With possibilities that exist in connexion with cross-cutting developments to explore both foot-wall and hanging-wall country, in which other vein occurrences have been indicated, it is evident that the present rate of expansion of this undertaking is regulated by a strictly conservative outlook and that the maintenance of the present scale of monthly production of a value of about $146,000 in Canadian money is assured for some years

to come. Pioneer Gold Mines of B.C., Ltd., has recently declared payment of a quarterly instalment of dividend at the annual rate of 24% on the issued capital. Treatment capacity at the Bralorne property has been stepped up to 125 tons per day in order, it is said, to compensate in some measure for an anticipated drop in the value of heads to the mill, resulting from the inclusion of rock from development now in progress. Within the scope of the operations that were put into force by Bralorne Mines with the commencement of production in February, 1932, a very creditable record of performance has been made and under similarly exceptional conditions of satisfactory development as were experienced at the Pioneer mine a continuance of profitable operation might be entertained. The view may be held, however, that the King vein is not to be compared with the Pioneer vein, as representing the major opportunity in connexion with development. The Reward Mining Company, holding properties in the upper valley of Cadwallader Creek, has given an option to Vancouver interests, by which further exploration will be conducted this season. This active organization is reported as having acquired other gold properties on Vancouver Island and in the Nelson district, adjoining the Venus-Juno-Athabasca groups. It is understood that Dr. Victor Dolmage will examine and report upon these newly-acquired properties of Reward Mining Company. It is reported that a second vein has been encountered in a cross-cut tunnel that is being driven by Bridge River Exploration Company for the purpose of further depth-development on the California vein. The new vein, which is said to be 2 ft. wide, was intersected at a distance of 140 ft. from the portal of the tunnel. It is understood that a Vancouver syndicate is financing further development on the Wayside property, situated in the main Bridge River valley. Bodies of quartz, from which high values in gold have been obtained from surface workings and in shallow tunnels, occur in sheeted zones of an augite-diorite stock and one vein has been traced for a considerable distance. A tunnel was driven several years ago to a distance of over 1,000 ft. on what appears to be a parallel zone in the hanging-wall, but no appreciable values were encountered. It is understood that it is proposed to continue a cross-cut from this tunnel to intersect the main vein at a depth of 300 or 400 ft. below the outcrop.

Atlin.—A strike of unusually rich pay gravel has been made recently in placer workings on Otter Creek, where Des Moines d'Or de Canada has been engaged for the past three or four years in hydraulicking operations. It is said that an old channel has been exposed in which values of $25 per cu. yd. have been obtained, but J. E. Moran, manager of the French company, states that a considerable amount of prospecting work will be required before the extent of the occurrence can be estimated. The company has done a great deal of work in flume and ditch construction and has been able up to the present time, according to the manager, to break even.

Kootenay.—The Chieftain group of gold quartz claims, situated near Burton City, on the Arrow Lake, has been acquired by Beaver Silver Mines, Ltd., following suspension of its operations at the Beaver Silver mine at Beaverdell. This property was opened up several years ago, when two tunnels were driven to explore a vein that is said to offer promise of gold and silver production. It is understood that equipment is being moved from the Beaver Silver mine for the purpose of establishing a camp and carrying on development. The property is situated at something over 4,000 ft. elevation and there are said to be facilities for the construction of a road from Burton City at small cost.

Kamloops.—Rumours are current that the Windpass mine, on the east side of the North Thompson river, is to be reopened. This property attracted a considerable amount of attention some years ago when it was under operation by the owners, Messrs. Trites, Willson, and Woods, and later by a New York syndicate, represented by B. N. Sharpe, by whom an option was held for about two years. The vein at surface was characterized by occurrences of massive lodestone showing free gold and the initial development, which was carried down to a depth of 100 feet, proved a fairly continuous body of ore, in which tellurides occurred, over a distance of 200 feet, with an average width of about 3 ft. and an average value of $35 per ton. Winze workings below this level were carried down at an angle of about 45° and passed into the foot-wall of the vein and with this apparent discouragement the work was stopped. Under Mr. Sharpe development was carried down to a further depth of 100 ft. and some very high values were encountered.

The ore-body was not, however, continuous and, with the failure to come to any definite understanding of the ore occurrence after the winze entered barren ground below the 200-ft. level, the option was relinquished. A spasmodic attempt was made to reopen the workings by the owners, with a view to realizing on the proven reserves of ore, which were calculated to be more than sufficient to offset the outlay on a treatment plant, but this project was not carried through and the property has lain idle for the past four or five years. An interesting theory of the ore deposition has been advanced, by which it might appear that there is considerable justification for further development. It is suggested that the mineralization is intimately related to a system of cross fracturing, with which all the spots of high enrichment in the flat-dipping vein are identified. In addition to the original shaft-sinking and driving a drive was run from the 100-ft. level of the winze and at an intermediate horizon and a careful record was kept by Mr. Sharpe of all assay values. The property is thought to represent an unusually attractive prospect at this time, possessing potentialities in addition to assurance of production from the ore reserves already proved.

Boundary.—Renewed interest is being taken in the Fairview gold camp as a result of the work carried out by R. L. Clothier recently in unwatering the shaft workings of the Morning Star property. This mine was worked over 30 years ago and the shaft has not been unwatered since that time. It is said that a body of ore 35 ft. in width has been exposed on the 80-ft. level and at the present time engineers representing important interests are on the ground and a careful sampling is being conducted. The Fairview camp was the scene of active operations at the beginning of the century and has been described as embracing the largest showings of gold-quartz in the province. Systematic sampling of extensive bodies of ore in the Stemwinder and other mines has indicated a value of about $5 per ton. Possibilities for large-scale operations are thought to exist. The Guggenheim interests control large holdings in the camp.

Sheep Creek.—According to O. C. Thompson, general manager of the Reno Company, the initial treatment operations in the new mill have been productive of a recovery valued at about $30,000 in bullion and in values locked up in the cyanide circuit from an amount of 1,664 tons of ore treated. The grade of the ore treated is stated to have been lower than the average of the reserves in the mine. The plant, in which all the tanks are of steel construction, is said to be functioning well. The ore is crushed coarse at the mine and is delivered by the 12,600-ft. aerial ropeway, with a capacity of 15 tons of ore per hour, to a cone-crusher. The grinding circuit is composed of ball-mill and tube-mill, close circuited with classifiers, and agitation is conducted in four Pachuca agitators, following a primary thickener, and by mechanical agitation, following secondary thickening. Precipitation is effected in a Merrill-Crowe plant. Every unit in the mill is operated by electric power transmitted over an eight-mile high-tension line from the new hydro-electric installation on Sheep Creek. Auxiliary water-power equipment is also installed. The No. 5 tunnel at the mine is being driven ahead to penetrate the favourable ground in which the downward continuation of the sulphide ore-bodies that were encountered in the inner sections of the tunnels above is expected. After operating the Kootenay Belle property successfully on a limited scale for some months recently the private syndicate is offering shares in the Kootenay Belle Gold Mines, Ltd., for public subscription. The intention is to extend developments and embrace all the four veins that are known to occur and later to install a small Hadsell mill. During the period September 20 to December 10 last the mine shipped a total amount of 235 tons of ore to Trail, of an average value of $30 per ton.

Nicola.—It is understood that arrangements have been made in New York and Montreal by Peter Bancroft, president of the organization by which the Planet mine, at Stump Lake, was operated two or three years ago, whereby Nicola Mines and Metals, Ltd., will be financed to acquire and operate the mine together with the adjoining Donohoe properties. The former company, Planet Mines and Reduction Company of Nicola, Ltd., failed to make a commercial success of the operation of this individual mine, but it is generally believed that an extended plan of development to embrace all the possibilities of ore reserves that are related to the vein system of the area would have a good chance to be successful.

TORONTO

March 18.

Gold Production for Ontario.—A report issued by the Ontario Department of Mines gives the production of gold for February at $3,615,354, from the treatment of 424,922 tons of ore, as compared with $3,505,198 from 473,739 tons in the previous month. In January the Kirkland Lake field produced bullion to the value of $1,787,399, as compared with $1,770,131 in the preceding month, the Porcupine field yielded $1,733,265, as compared with $1,615,355, and North-Western Ontario $94,690, against $119,712.

Sudbury.—The annual report of International Nickel for 1932 shows a net loss of $135,344, after all deductions, as compared with a net profit of $5,094,497 for the previous year. After all deductions except preferred dividends the final quarter of the year showed a net profit of $154,007. Total nickel deliveries in the world market except America were only 7% less than in 1931, practically all the decrease in total nickel consumption having occurred in the American market, where the decreases amounted to about 27%. Earned surplus was $14,688,559, compared with $16,757,813 a year earlier, the reduction reflecting the net loss of the year and the payment of the preferred dividend. Capital surplus at the end of 1932 stood at $59,924,194. The annual report of Falconbridge Nickel for 1932 shows net operating profits of $762,421, as compared with $10,551 at the close of the previous year. During the year the company sold its products to 77 customers in 11 different countries and produced 5,408,373 lb. of nickel and 2,288,897 lb. of copper. Sales of nickel aggregated 7,844,648 lb. The estimated ore reserves totalled 2,920,457 tons. The new 300-ton concentrator and sintering plant will begin operations early next month, according to present plans. Lateral work is being concentrated on the 350-ft. level and development commenced on the 500- and 750-ft. levels is responding to expectations. There is continued activity in prospecting for gold in the Swayze area, the interest being maintained by several new discoveries. At the Kenty two shafts are being put down to an objective of 500 ft. and when the first level at 125 ft. is reached some lateral work will be done. Surface developments on the property of the Halcrow-Swayze Mines, Ltd., have disclosed evidence of a substantial ore-body. Shaft sinking is now under way and a mining plant is being sent in. An important discovery has been made on the property of the Lee Gold Mines. The vein has been encountered in a mineralized shear-zone alongside a porphyry and quartz intrusion. About six feet of the vein has been opened up and showed values of about $6 per ton in gold. Shibougamau Prospector's, Ltd., has taken up a group of claims covering about 800 acres on which surface prospecting has been attended with satisfactory results.

Porcupine.—Dome Mines reports bullion production for February at $381,565, compared with $364,879 for January, the milling-rate averaging about 46,000 tons for the month. The company is preparing for deeper mining and a winze has been started from the 23rd level and will go down about 125 ft. to open up a new horizon. Development work on the lower levels is stated to be opening up good stretches of ore that run about $12 per ton in gold. Millheads now run $8 per ton. Dome Mines has obtained satisfactory results from diamond drilling on the Hughes property, situated about four miles from its main holdings. The company has also taken an option on the Mulholland property adjoining and will start exploration in the near future. Hollinger Consolidated is reported to be considering the acquisition of the South Keora Mines property located about 4½ miles distant. Some trouble has been encountered in supplying mill feed at the rate of 4,800 tons per day, despite the fact that it has been building up ore reserves, and by acquiring the Keora property and building a tram-line it would have a new source of ore that could be speedily opened up at a relatively low cost. Development of the contact zone along the north side of Pearl Lake at upper levels of McIntyre Porcupine Mines has taken on some importance. A series of ore lenses from 250 to 400 ft. in length are being opened up in Jupiter ground and there is every reason to believe that as exploration progresses more lenses will be located. Work to date has been largely confined to the 400- and 600-ft. levels, but recently a lens was entered at the 1,000-ft. level. Cross-cutting towards this area at the 900-ft. level is under way and it is also proposed to explore the downward extension of the zone on levels between 1,000 and 1,800 ft. as quickly as possible. Three lenses, each slightly more than 300 ft. long, have already

been opened up on the 600-ft. level. Four lenses have been developed, each 250 ft. long, and a fifth has been entered on the 800-ft. level, grade of this ore averaging between $12 and $13 for the width of the drive. The sinking of the new winze below the 3,875-ft. level will shortly be under way. The Vipond has discovered a new vein on the 500-ft. level. It was found in virgin territory and where intersected showed a width of 5½ ft., with an estimated grade of $8 per ton in gold. There seems to be a good chance that other veins of importance will be found in the vicinity, which may prolong the life of the mine. Buffalo-Ankerite Mines is showing a small profit on operations and since work started last April has accumulated approximately 20,000 tons of broken ore, increased the mill capacity to 325 tons daily, and expended a considerable sum on development and diamond-drilling work. A large amount of ore has been mined on No. 1 vein on the 200-ft. level, which has maintained an average grade of $6 per ton.

Kirkland Lake.—The management of the Lake Shore has made some important changes in the staff of the mine. The cause is stated to be dissatisfaction with the high cost of production. The management has no intention of increasing the tonnage going to the mill unless unforeseen circumstances arise, their settled policy being the maintenance of the present rate. The total value of gold production to the end of 1932 is estimated at approximately $53,500,000. The Wright-Hargreaves has for some time past been maintaining a mine development programme calling for heavy expenditures. The company will continue development work on a large scale, special attention being given to new levels down to 4,000 ft. It is also proposed to increase the capacity of the mill to bring it up to 1,000 tons per day from its present rate of 800 tons per day. Teck-Hughes has started a cross-cut to open up a new ore deposit found about two months ago, about 1,200 ft. north of the present workings. The work will require probably five months. Sinking will be resumed and a winze put down north of the south shaft, with an objective of 6,000 ft. From the 20th to the 31st levels practically all the development has been done and stoping has been undertaken down to the 35th level. Mill feed is being drawn from the 27th to the 33rd levels, with an average grade of about $10 per ton. Sylvanite Gold Mines has cut the north vein on the 2,750-ft. level. The ore grade is stated to average approximately $11 per ton. A rise is being run from the 3,000-ft. level and is in $11 ore. Kirkland Lake Gold in 1932 produced bullion to the value of $524,323, income from all sources amounting to $606,691. After all deductions there remained a net income of $137,214. At the Barry-Hollinger a favourable new ore-body has been located on the 1,700-ft. level in the west drift, assays averaging $17·50 per ton. The property of the Kirkland Consolidated Gold Mine, in Grenfell township, is being developed. A shaft has been put down 125 ft. and lateral work done with encouraging results. The shaft will be deepened and active development carried on. The Kirkland Gold Belt has been acquired by Buffalo interests. The underground workings are being dewatered and work is now proceeding. The ore-shoot on the 2,325-ft. level at Macassa Mines has been extended 250 ft., with the face still in ore. Values are stated to average about $20 per ton. The Ashley, in the Matachewan area of the district, is treating an average daily amount of 105 tons, with an average grade of $12 per ton. Development is making steady progress.

North-Western Ontario.—The mill of the Moss Mine, in the Thunder Bay district, is treating an average of 85 tons daily, with a recovery of about $7·50 per day. The company has had some trouble with its mill, but this is being gradually overcome and an increase in recovery is looked for. The Parkhill gold mine, in the Michipicoten area, has increased the capacity of its mill, bringing it up from 40 to 100 tons per day. Millheads now average $23 per ton in gold. During 1932 the Howey Gold Mines, in the Patricia district, milled 329,249 tons of ore and produced bullion to the value of $1,268,780, the cost per ton treated being $2·47, as compared with $3·12 for the previous year. Limited work between the 1,000- and 1,315-ft. levels disclosed ore reserves of approximately 500,000 tons. At the Central Patricia equipment for the 60-ton mill has arrived on the property and construction will be actively proceeded with, completion being expected early in July. Bathurst Mines, in the Woman Lake district, has reached a small but definite production basis, with a five-ton pilot mill. The mine is responding favourably to development and will be placed on a two-shift basis.

North-Western Quebec.—The demand for gold and the consequent impetus to prospecting and exploration has considerably widened the known gold-bearing Rouyn area. It is announced that in the near future a new railway—the Montreal and Western Quebec, understood to be a subsidiary of the Canadian Pacific Railway—will be built to open up communication with the heart of this field. The Siscoe Gold Mines reports gold production and other income for 1932 of $1,135,931, the operating profits being $771,125 and the net profit after all deductions $551,918. The total tonnage treated was 63,998 and the average value per ton $15·94. The company has completed the installation of the new cyanide flotation unit and ball-mill, which will bring the mill capacity up to 225 tons per day. Granada Gold Mines is planning to increase the scope of mine development, special attention being given to the eastern section of the property. The new Hadsel mill is showing improvement in operation, but there are still some adjustments to be made. The combined capacity of the old and new mills, both operating, is approximately 175 tons per day. Development in the lower levels has opened up some high-grade sections, the grade improving at depth. The light railway to the Beattie Gold Mines is operating satisfactorily and has expedited the transport of material and equipment. The new shaft is progressing at a rapid rate, while the mill construction has also made good headway. Pandora Mines has met with good success in diamond drilling, having encountered two well-mineralized veins. Development on the 250-ft. level continues to open up high-grade ore and the vein is lengthening out, with no loss in width or values. The McWatters Gold Mines has completed its diamond drilling campaign. Shaft sinking has been started and the three-compartment shaft is to be sunk to a depth of 400 ft. Stadacona Rouyn Mines has resumed sinking and an enlarged three-compartment shaft is to be taken down to a depth of 1,000 ft. Lateral work is opening up good values. Diamond drilling having revealed favourable indications on the Bagamac, tenders have been called for the sinking of a shaft to a depth of 100 ft. Arntfield Gold Mines is making good progress in development work and a new mining plant is being installed. The Treadwell Yukon has opened up a new high-grade ore-body on the 600-ft. level. The mill is treating 100 tons per day of an average grade of $10 per ton.

Manitoba.—The Flin Flon plant of the Hudson Bay Mining and Smelting Company is now handling 4,300 tons of ore per day. Increased tonnage, lower operating expenses, and wider economies make it possible for the plant to continue operations profitably. Gold content and silver by-products are holding up well. The company has established a plant for the manufacture of the steel balls required in the crushers, which effects a considerable saving. The Western Cryderman Gold Mines, Ltd., has taken over the old Cryderman property in central Manitoba. The old shaft, now at a depth of 250 ft., will be deepened and may be taken to a depth of 1,000 ft. to open up the known vein on the lower horizons. The San Antonia is maintaining production at the rate of about $80,000 per month. A new shaft is being put down from the surface to facilitate hoisting and general mine operations.

PERSONAL

W. Baddeley Adams is returning from the Sudan.

W. P. Alderson has left Canada for Kenya.

J. Atkinson has left Australia for Siam.

Frank Ayer, until recently general manager of the Morenci branch of the Phelps-Dodge organization, has been appointed general manager of the Roan Antelope mine in place of D. D. Irwin, who has resigned. Mr. Irwin retains his office as a director of the company.

W. H. Beak has left for Sierra Leone.

C. A. Brodigan has returned from the Gold Coast.

M. D. Calder is now in Canada.

W. R. Feldtmann is home from South-West Africa.

J. L. Ford is leaving for Nigeria.

A. Gravillon has left for the French Cameroons.

P. Mercer Hume has returned from the Gold Coast.

E. H. Jaques has left for the Gold Coast.

A. A. McMartin has left Canada for Kenya.

J. H. Marshall has left for Kenya.

M. Milstein has left Berlin for Mexico.

Charles A. Mitke is at present in Mexico.

W. Murray has left for Burma.

Balmer Neilly has been appointed president of the Canadian Institute of Mining and Metallurgy for the ensuing session.

A. E. Pleming has returned from West Africa.

G. H. Plowman has returned from the Gold Coast.

A. Prasso has returned to Paris from Abyssinia.

Francis J. Ryeland has returned from Colombia.

F. Schrieber is returning to Germany from Singapore.

A. C. Skerl is returning from Northern Rhodesia.

J. E. Snelus has left for Nigeria.

R. S. G. Stokes is here from Johannesburg.

R. A. Wadeson is now in Burma.

Benjamin B. Thayer and John D. Ryan, who died within a few days of each other in February, were respectively vice-president and chairman of the Anaconda Copper Mining Co.

William James, who died on March 27, at New Cooks House, had been in charge of the tin-dressing department at South Crofty since 1900, having previously held a similar position at Carn Brea and Tincroft.

Henry Claude Taylor, of Messrs. John Taylor and Sons, died suddenly on April 5, whilst returning from the City to his home at Slough. Mr. Taylor, who was 60, was a member of the Institution of Mining and Metallurgy.

Charles Frederick Thomas, who died recently at the Witwatersrand Deep mine, was the brother of Mr. William Thomas, of the Camborne School of Mines, whose death occurred a little more than a year ago. Mr. Thomas, after leaving Cornwall held appointments in Mexico, the Transvaal, Australia, New Zealand, Rhodesia, and Burma. He also managed the Prince of Wales Mine, near Gunnislake, and South Crofty at one time. When he returned to South Africa he held a position in Northern Rhodesia (at N'Kana) before proceeding to Johannesburg to take up the post of assistant manager at the Witwatersrand Deep. He was a Member of the Institution of Mining and Metallurgy.

Alexander Alexander Thomson, who lost his life, at the age of 52, in the accident to the air liner City of Liverpool on March 28 (when he was accompanied by Mr. C. F. Rowsell, who was also a victim of the disaster), graduated from the Royal School of Mines in 1905. After early experience at Anaconda and at Steptoe Valley Smelting Co., Nevada, Mr. Thomson was appointed manager of the Kansanshi mine, Northern Rhodesia, in 1912, leaving this position, to become technical secretary to the Union Minière and afterwards representative of Sir Robert Williams and Co. at Elizabethville, which he held till 1930, except during the period of the War, when he served with the Royal Engineers. In 1930 Mr. Thomson became consulting engineer of the Sir Robert Williams group and in 1932 joined the board of Tanganyika Concessions. Mr. Thomson was a Member of the Institution of Mining and Metallurgy.

Leslie Urquhart, M.Inst.M.M., who died on March 13, was the son of the late Mr. Andrew Urquhart, of Edinburgh, a member of an old Scotch family, and was born at Aidin, Smyrna, Asia Minor, on April 11, 1874. After being educated abroad, he studied engineering at Glasgow Engineering College and chemistry at Edinburgh University. In 1896 he joined his father in business in the Caucasus and some four years later was appointed managing director of the Schibaieff Petroleum Company, at Baku, Caucasus, and director of the Bibi Eibat Petroleum Company, becoming also in the following year general manager of the Russian Petroleum and Baku Russian companies, these four premier British oil companies producing during his management some 30% of the total output of petroleum in the Russian Empire. At this time, too, he was appointed British Vice-Consul at Baku. Mr. Urquhart was instrumental in settling many of the labour disputes at the Baku oilfields and incurred the enmity of the revolutionary society. His life was attempted in September, 1905, but, although struck by eight bullets, he escaped mortal injury. For his gallantry in saving the lives of three British employees during these troubles he was awarded the Albert Medal (First Class). In 1907 he formed the Anglo-Siberian Company and took up the Kyshtim Estates, in the Ural Mountains. Through the Perm Corporation he personally reorganized the whole of the Kyshtim business and subsequently formed the Kyshtim Corporation. A few years later he took up and developed copper mines in the Bashkir country, Orenburg, subsequently forming the Tanalyk Corporation for their exploitation. To further British mining interests in Russia he formed at this time the Russo-Asiatic Corporation and through this company took up the Ridder Mines, in the Altai Mountains, which he had previously investigated. In 1914, shortly after the outbreak of War, Mr. Urquhart formed the Irtysh Corporation to take over the Ridder Mines and the Ekibastous Collieries and railway, which had been subsequently acquired. Parallel with this he took up and partially developed large porphyry copper deposits in Western Siberia and in 1919 these were amalgamated in the well-known Russo-Asiatic Consolidated. In 1918 Mr. Urquhart was appointed a member of the British Government Economic Mission to Russia and proceeded to Moscow, via Murmansk and Archangel. This mission was without result, but his experiences at that time in Moscow were interesting, particularly his escape, despite the order of the Cheka for his detention. In the latter part of 1918 he was appointed as the British Government's Agent for Siberian supplies and used his organization to send food and supplies to the population in Siberia in an endeavour to resuscitate economic life there. It required vision, courage, and ability to build such an enormous and successful metalliferous industry in Russia and Mr. Urquhart successfully employed these qualities in other parts of the world after the confiscation by the Soviets of all the properties and assets of his companies in Russia. At the time of his death Mr. Urquhart was chairman of the Russo-Asiatic Consolidated, the Mining Trust, Mount Isa Mines, and the Britannia Lead Company and was a director of New Guinea Goldfields and Compagnie Nouvelle des Mines de Villemagne, in France. His loss cannot fail to be deeply felt by his associates and a wide circle of friends.

TRADE PARAGRAPHS

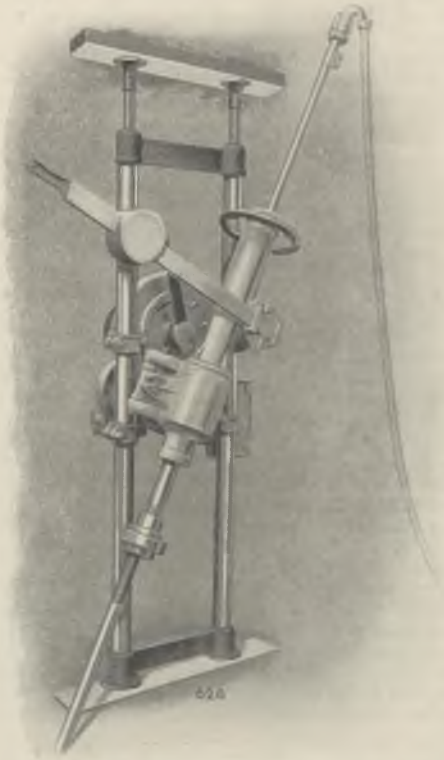
Geophysical Co. (Elbof), of Cassel, Germany (London representative: Mr. H. B. Bateman, 790, Salisbury House, E.C. 2), announce that they have a party prospecting in South India.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, issue a leaflet drawing attention to the advantages of the "Silvester" prop withdrawer, to which attention has already been directed in these columns.

Algernon Lewin Curtis, of Westmoor Laboratory, Chatteris, has published No. 3 of his periodical *Sands, Clays, and Minerals*. This contains, *inter alia*, articles on China Clay Mining in England; British Coals—Origin, Composition, and Classification; Examination of Minerals by Ultra-Violet Light, and Notes on Tantalum and Niobium. There are several good coloured plates among the illustrations.

Curchin and Watson, of Bevis Marks House, London, E.C. 3, announce that **Werf Conrad**, of Haarlem, Holland, have added a new diamond-

drilling machine for prospecting work in mines to their existing series of drilling plant. The outstanding feature of this drill is its entirely enclosed design, the gearing of the drill head and friction hoist running on ball bearings and in an oil bath. The machine is equipped with the super-sensitive counterbalance system for diamond drilling, with which all Conrad diamond drills are equipped. The drill is made for compressed-air or electric drive and its capacity is about 400 ft. with size EX bits.



WERF CONRAD DIAMOND DRILL.

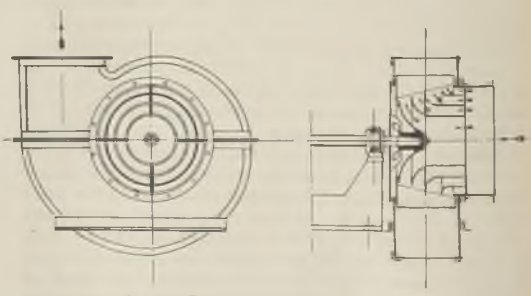
General Engineering Co., Inc., of Adelaide House, London, E.C. 2, issue a leaflet describing the "Geco" suction-pressure diaphragm pump for handling thick suspension sludges and such-like in mill circuits. The use of a large fixed but flexible diaphragm in place of a sliding piston avoids the evils of excessive wear and consequent leakage. Another essential feature of this pump is that the delivery valve is in a separate valve chamber and consequently it may be used as a suction pump and as a delivery pump. The pump is made in three sizes, 2, 3, and 4 in., and either simplex, duplex, or triplex; it may be belt or motor driven and has capacities ranging from 5 to 100 gallons per minute.

"GECO" DIAPHRAGM PUMP.

United Electrical Engineers, Ltd., is the title by which four electrical engineering firms who have agreed to merge their Canadian branches will be known. The parties to this combine are Lancashire Dynamo and Crypto Co., of Canada, Ltd., Bruce Peebles (Canada), Ltd., Harland Engineering Co. (Canada), Ltd., and Crompton Parkinson (Canada), Ltd. The head office of the company will be at 1050, Mountain Street, Montreal, with a branch at 43–45, Niagara Street, Toronto.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, publish parts 12 and 13 of their *Engineering Educator*. Part 12 commences the subject of blast-furnace practice, which includes reference to the design of blast furnaces and auxiliary equipment, the method of blowing, and the handling of the products, followed by a chapter on fuels. A section on special steels by Sir Robert Hadfield also commences in this part. Part 13 introduces pattern-making and foundry work.

Scott and Strutt, Ltd., of 25, Victoria Street, London, S.W. 1, have made arrangements for **Fraser and Chalmers Engineering Works,** of Erith, to manufacture under licence Adra fans to the De Raedt design. This fan has already established a good reputation on the Continent and it is noteworthy that 24 of them are in use for ventilation of the tunnel under the Schelde at Antwerp. Various types of Adra fans are made, suitable for mine ventilation, the treatment of flue gases in power generation, and other purposes. The fan is of the centrifugal type and, while conforming to conventional design, the makers claim that it has a high efficiency over a wide range of resistances. As an example, an 11½-ft. fan of 550 h.p. maintains an efficiency of 70% and over on resistances varying between one half and twice the normal, figures obtained in a Belgian colliery. A feature of the induced-draught fan for flue gases is the patent intake distributor illustrated here. This has been devised to minimize wear on fan blades due to the abrasive action of solids in suspension in the gas stream. As is well known,



ADRA INTAKE DISTRIBUTOR.

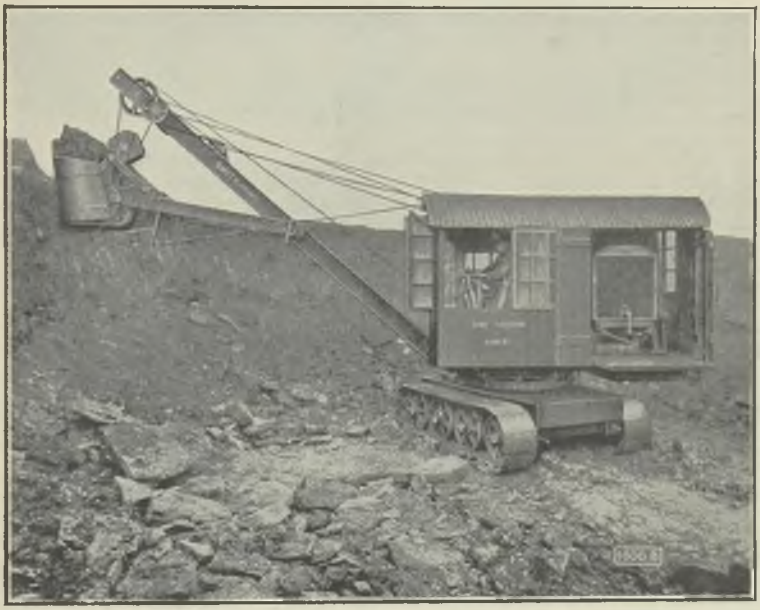
the wear is of a serious nature, because the dust which is thrown by virtue of its velocity against the back plate of the fan traverses the blades only along that portion adjoining the back plate and cuts deeply into the blade at that point. The reduction in wear is achieved by splitting the air stream at the suction eye, so that the impact of the dust particles is spread over the whole area of the fan blade and thus localized abrasion is eliminated. By curving the end of the distributor, as shown, the flow of the gases is so diverted that the entry to the blade is effected with a minimum of shock.

Lincoln Electric Co., of Cleveland, Ohio (London representatives: Buck and Hickman, Ltd., 2, Whitechapel Road, E. 1), announce the publication of "Designing for Arc Welding," which contains prize-winning papers submitted in their second competition. It includes sections on machinery, shipbuilding, buildings and bridges, large containers, and piping and fittings. Among other developments discussed are the use of arc-welded alloys for corrosion resistance, the substitution of arc-welded steel for aluminium without weight increase, the welding of high-tensile steels, and structural design for resistance of earthquake shocks.

Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, London, W. 4, announce an important improvement in their "Megger" earth tester with a view to overcoming its previously existing limitations when used in the resistivity method of geophysical surveying. The new instrument is described as a low-range (or geophysical) Megger and is direct reading with two ranges—one from 0 to 0·3 and the other from 0 to 3·0 ohms, it being possible to obtain accurate readings as low as 0·05 ohms. Thus the range of operation has been increased and electrode separation as much as 1,500 ft. can now be employed under normal conditions.

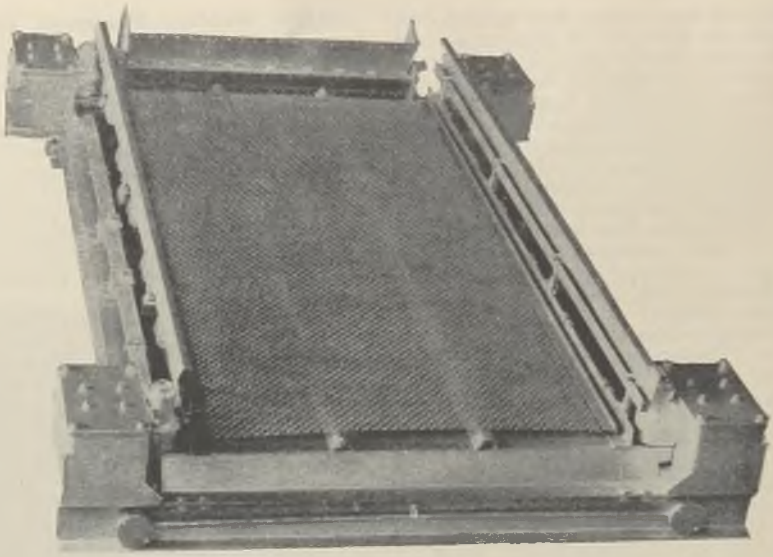
Murex Welding Processes, Ltd., of Ferry Lane Works, Forest Road, London, E. 17, have published the fourth edition of their "Handbook for Electric Welders." This contains details of welding plant; the electric arc and electrodes and their uses; instructions for beginners, and applications of welding, including the making of a fillet-weld, a butt-weld, welding repairs to cast iron, welding of stainless steels, and welding of copper and brass. Other chapters deal with the physical properties and mechanical testing of weld materials, metallography as applied to welding, the strength of welded connexions, and estimating quantities in welding.

Thomas Smith and Sons (Rodley), Ltd., of Leeds, have recently issued a booklet completely illustrated and fully describing their standard universal excavator, which is made in two sizes—viz., $\frac{1}{3}$ and $\frac{1}{2}$ cu. yd. These excavators are fully convertible as shovels, scoops, trenchers, draglines, grab cranes, ordinary cranes, or pile drivers. They are mounted on the usual caterpillar wheels and have a Diesel engine power unit or, as an alternative, either petrol or petrol-paraffin engine or electric motor can be fitted. The illustration shows a Diesel-engine-operated shovel.



SMITH $\frac{1}{2}$-YD. EXCAVATOR.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, have published a leaflet describing the type 400 Hum-mer screen. As will be evident from the accompanying illustration this screen represents a radical departure from previous Hum-mer practice, inasmuch as the vibrator mechanism, instead of being located over the centre of the screen, is now composed of four separate units at the corners, each pair being yoked together by a cross armature beam. The vibrator provides 1,800 short powerful strokes per minute, combined with a sharp impact, and it is claimed that the intensity of vibration considerably exceeds that of any other screening device. Equal distribution of the vibration over

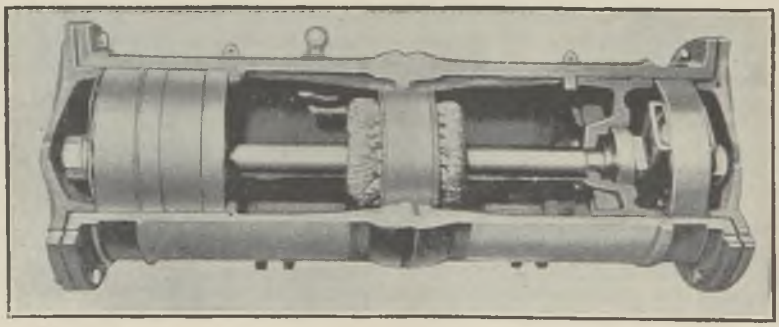


TYPE 400 HUM-MER SCREEN.

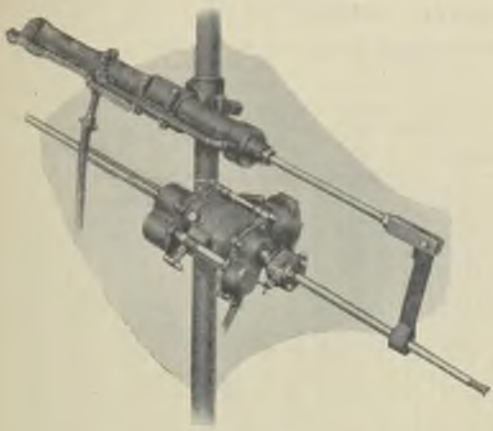
the whole surface is also claimed. There are means for keeping the screen cloth in constant tension, so that it is not subject to racking or bending motion and is, therefore, only worn out by actual abrasion. They also report having received the following orders:—For England: One 3 ft. by 8 in. Hardinge ball-mill for material of similar hardness to chalk, two 6 ft. by 5 ft. 2-surface type 31 Hum-mer electric screens for free-flowing material similar to dry sand, one 50 sq. ft. "Rovac" filter for crude naphthalene oil, one 3 in. Grit pump for slurry containing 65% finely-divided crystalline material, and one Ro-Tap testing sieve shaker for laboratory work. For Egypt: One 4-roller Raymond mill for talc. For South America: One 4 in. Grit pump for work in conjunction with an Andrews classifier. For abroad: One 3 ft. by 18 in. Hardinge ball-mill for grinding a mixture of anthracite, coal, and coke.

H. R. Marsden, Ltd., of Leeds, publish particulars of the Mitchell screen, which is of the vibrating type. The vibration is caused by unbalanced weight. In the cylindrical housing shown in the illustration is pressed a motor stator unit at the exact centre. Through this runs a shaft with its attached rotor. At each end of the shaft is imprisoned a square cage. At one end of the shaft a solid ball is imprisoned in the cage and at the other end, 180° opposite from the first ball, a second is inserted, the balls running in hardened-steel races. The shafts are ball-bearing, the rotor speed being 3,600 r.p.m., and each revolution provides one vibration. It is calculated that with a 2 in. ball, which is the standard equipment, the force of each vibration exceeds 2,600 lb. The normal operating angle of the Mitchell screen is 28° to 40°, but it can be adjusted to suit specific requirements. It is designed for a.c. at various voltages. The vibrator mechanism referred to above is mounted above the top of the screen surface and well clear of it.

Sullivan Machinery Co., of 400, North Michigan Avenue, Chicago (London office: 819, Salisbury House, E.C. 2), have issued a description of their new No. 6 one-man core-drill for underground use and also a newly devised pneumatic rod puller for use on this machine, or on others which do not carry a hoist. The core-drill has a capacity of from 50 to 150 ft. in depth and is intended to meet the need for a light, compact machine for shallow underground exploration in



MITCHELL SCREEN VIBRATOR MECHANISM.



SULLIVAN No. 6 CORE-DRILL AND PNEUMATIC ROD PULLER.

advance of drifting, stoping, etc. It uses standard fittings, either $\frac{15}{16}$ in. or $\frac{7}{8}$ in. core. It will drill at any angle. A hinge or clamp is furnished, so that when pulling or lowering rods out of or into the hole the entire drill mechanism can be swung back out of the way. The drill is operated by a compressed-air ("turbinair") motor. The swivel head is equipped with three sets of feed gears providing from 200 to 600 revolutions of the spindle for each foot drilled and change gears are furnished for either slower or faster drilling. The pneumatic rod puller consists of cylinder and piston, with a valve and pipe connexions to admit compressed air to either side of the piston. To the other end of the piston rod is screwed a fork and in this is loosely held at right angles an arm carrying a hand-like grip, which encircles the drill rod to take hold of the rod when the arm is pulled inward by the piston. Grips are available to handle rods of different sizes. The illustration shows the diamond drill set on a column for an angle hole and equipped with the pneumatic rod puller.

METAL MARKETS

COPPER.—The copper market during March was, of course, seriously disturbed by the American banking troubles, which culminated in a general banking moratorium over there. On apprehensions that the dollar might be inflated considerable speculative purchasing appears to have been effected and this pushed up the American quotation for electrolytic from 5 cents to 5·75 cents per lb. delivered Connecticut Valley. Industrial conditions not justifying the advance the price subsequently receded to 5 cents again. The export quotation also rose from 4·90 cents per lb. c.i.f. Europe to 5·40 cents, but closed the month at barely 5 cents. European trading conditions remained somewhat unsatisfactory.

Average price of Cash Standard Copper: March, 1933, £28 4s. 4d.; February, 1933, £28 10s. 6d.; March, 1932, £33 1s. 9d.; February, 1932, £36 19s. 8d.

TIN.—The standard tin market last month exhibited a fairly good tone and support of one kind or another kept values close round the £150 level. Sentiment is fairly optimistic having regard to the fact that restriction is now definitely resulting in a regular decline in the "visible supply" month by month. A feature of the month was the growing unrest amongst Malayan producers, amongst whom the conviction is spreading that the present distribution of quotas under the restriction scheme bears inequitably upon them. There was a moderate industrial demand in America and Europe during the past month.

Average price of Cash Standard Tin: March, 1933, £149 4s. 1d.; February, 1933, £148 12s. 7d.; March, 1932, £129 18s. 2d.; February, 1932, £139 4s. 7d.

LEAD.—Although this market did not escape the temporary inflationary tendencies—due to the American banking collapse which, logically or illogically, assisted in strengthening sterling values about the middle of March—there has been no real expansion in industrial demand and the month closed with rather an unsatisfactory tone. Japan seems to have shown some interest in the metal for war requirements, but she did not buy in London. Producers' excess stocks remain in the neighbourhood of 500,000 tons and obviously the situation is not particularly brilliant in these circumstances. The American statistical situation has become worse and a big producer over there is shutting down.

Average mean price of soft foreign lead: March, 1933, £10 14s. 3d.; February, 1933, £10 11s. 6d.; March, 1932, £12 9s. 9d.; February, 1932, £14 11s. 3d.

SPELTER.—The past month opened with a good tone thanks to the news that the International Zinc Cartel had been provisionally prolonged and that the statistical situation was developing fairly satisfactorily—at least outside the United States. Demand from users, however, has remained rather dull. The American price went up during the banking collapse, but has since fallen again.

Average mean price of spelter: March, 1933, £14 13s. 2d.; February, 1933, £13 19s. 10d.; March, 1932, £12 16s. 4d.; February, 1932, £14 1s. 7d.

IRON AND STEEL.—Favourable influences were at work on the British pig-iron market during March. Home demand expanded and additional furnaces were blown in. Cleveland quotations remained steady, with No. 3 g.m.b. priced at 62s. 6d. delivered to local consumers. Hematite was a rather better market, although makers still seem handicapped by stocks and East Coast Mixed Numbers had a harder tendency around 59s. per ton. The steel market was rather more cheerful, particularly as some fair home and foreign rail orders were booked and the improvement at the shipyards is also expected to react favourably on the activity of the mills in the near future. Imports of Continental steel, particularly semis, have been heavily reduced by the tariff and this is another good factor from the mills' point of view. The Continental steel market was irregular.

IRON ORE.—There is a little more moving than was the case two or three months ago, but large-scale buying is still conspicuously absent. The outlook is probably brightest in this country. Prices keep fairly steady, best Bilbao rubio being about 15s. 3d. per ton c.i.f.

ANTIMONY.—Practically throughout the past month business has remained at a very low ebb and the undertone of the market is rather easier. English regulus is still quoted at £37 10s. to £42 10s.

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard		Electrolytic	Best Selected.				Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Mar.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
10	28 11 10½	28 18 1½	33 0 0	30 10 0	149 3 9	149 18 9	14 17 6	11 2 6	12 10 0	18 5/16	18 1/8	119 2½
13	29 4 4½	29 9 4½	34 0 0	—	150 1 3	150 13 9	15 2 6	11 5 0	12 15 0	17 3/8	17 13/16	120 2
14	28 15 7½	29 0 7½	33 17 6	30 10 0	149 6 3	149 18 9	14 17 6	10 17 6	12 10 0	17 11/16	17 3/4	120 3
15	28 6 10½	28 11 10½	33 7 6	—	148 18 9	149 13 9	14 18 9	10 11 3	12 5 0	17 9/16	17 5/8	120 3
16	28 7 6	28 12 6	33 0 0	—	149 17 6	150 11 3	14 18 9	10 13 9	12 5 0	17 7/8	17 15/16	120 0½
17	28 3 1½	28 8 1½	32 15 0	30 10 0	149 10 0	150 2 6	14 16 3	10 11 3	12 0 0	17 5/8	17 11/16	120 3
20	28 0 7½	28 5 7½	32 7 6	—	148 13 9	149 11 3	14 15 0	10 7 6	11 15 0	17 1/4	17 5/16	120 2
21	28 4 4½	28 9 4½	32 12 6	30 10 0	148 13 9	149 11 3	14 12 6	10 8 9	11 15 0	17 7/16	17 1/8	120 4½
22	28 1 10½	28 8 1½	32 12 6	—	148 11 3	149 6 3	14 11 3	10 10 0	12 0 0	17 7/16	17 1/2	120 9
23	28 5 7½	28 11 10½	32 15 0	—	149 6 3	150 1 3	14 15 0	10 12 6	12 0 0	17 11/16	17 3/4	120 6½
24	28 13 1½	28 18 1½	33 0 0	31 0 0	151 7 6	152 0 0	14 17 6	10 13 9	12 0 0	17 7/16	17 1/2	120 6
27	28 11 10½	28 16 10½	33 0 0	—	151 8 9	152 6 3	14 15 0	10 12 6	12 0 0	17 7/16	17 1/2	120 10½
28	28 3 9	28 8 9	32 15 0	30 15 0	150 3 9	150 18 9	14 11 3	10 10 0	12 0 0	17 1/8	17 9/16	120 9½
29	28 3 1½	28 8 9	32 15 0	—	150 16 3	151 13 9	14 13 9	10 6 3	11 15 0	17 11/16	17 3/4	120 11½
30	28 3 9	28 9 4½	32 10 0	—	150 15 0	151 11 3	14 16 3	10 8 9	12 0 0	17 9/16	17 5/8	120 5½
31	28 5 7½	28 11 10½	32 10 0	30 15 0	151 5 0	152 2 6	14 17 6	10 10 0	12 0 0	17 3/8	17 7/16	120 4
Apr.												
3	28 4 4½	28 10 7½	32 5 0	—	151 8 9	152 10 0	14 7 6	10 10 0	12 0 0	17 1/4	17 5/16	120 4½
4	28 1 10½	28 8 1½	32 0 0	30 10 0	152 2 6	153 1 3	14 8 9	10 7 6	12 0 0	17 1/4	17 5/16	120 7
5	28 5 7½	28 10 7½	32 2 6	—	153 11 3	154 10 0	14 8 9	10 6 3	11 15 0	17 5/16	17 3/8	121 0
6	29 1 3	29 6 10½	32 17 6	—	153 16 3	154 13 9	14 15 0	10 10 0	12 0 0	17 7/16	17 1/2	120 9½
7	29 9 4½	29 14 4½	33 15 0	31 15 0	154 17 6	155 12 6	14 17 6	10 13 9	12 5 0	17 1/2	17 9/16	121 0
10	29 13 9	29 16 3	34 10 0	—	156 2 6	156 18 9	15 1 3	10 15 0	12 5 0	17 3/8	17 7/16	120 11

per ton, with Chinese regulus for forward shipment about £22 15s. to £23 c.i.f.

Arsenic.—Mexican high-grade remains at £18 to £18 5s. c.i.f., with Cornish white about £19 f.o.r. mines.

Bismuth.—Business is not impressive, but prices are maintained steadily at 4s. 6d. per lb. for 5 cwt. lots and over.

Cadmium.—Demand has been somewhat dull recently and prices now stand at about 1s. 6d. per lb.

Cobalt Metal.—The official price continues at 7s. per lb.

Cobalt Oxides.—Dull conditions have ruled in this market recently and prices remain rather variable between 4s. 9d. and 5s. 2d. per lb. for black and 5s. 4d. and 5s. 7d. for grey.

Chromium.—The market is quietly steady at 2s. 9d. per lb. delivered.

Tantalum.—Only limited quantities are called for, but prices keep fairly steady at about £15 per lb.

Platinum.—Early in March the undertone was definitely weak, but later some better consumptive buying helped matters and the official price has been raised to £7 10s. per oz.

Palladium.—The market is quietly steady at the unaltered prices of £4 to £4 10s. per oz.

Osmium.—Supplies are not particularly plentiful and quotations are upheld at £12 to £12 10s. per oz.

Iridium.—Demand is poor, but prices show no change at £9 10s. per oz. for sponge and powder.

Tellurium.—Business is confined to trifling parcels and quotations are nominally unaltered at about 20s. per lb.

Selenium.—Leading interests continue to quote 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse Liverpool.

Manganese Ore.—Some odd cargoes have been sold to the Continent, whilst consumption in this country is rather better than it was at the beginning of the year. Generally speaking, however, the market is very slow. Prices remain at 9½d. per unit c.i.f. for best Indian and 8½d. to 9d. c.i.f. for 50 to 52% washed Caucasian ore.

Aluminium.—Only a moderate demand has been seen in recent weeks, but prices are without change at £100 for ingots and bars and £102 for rolling billets, both less 2% delivered.

Sulphate of Copper.—Some fair sales have been made recently, but prices are unchanged at £15 15s. to £16 5s. per ton, less 5% for British material.

Nickel.—Sales have been maintained on the better scale established recently, but prices have been adjusted to £240 to £245 per ton, on account of exchange considerations.

Chrome Ore.—The market remains depressed, but prices are quotably unchanged at 80s. to 85s. per ton c.i.f. for first quality 48% Rhodesian ore and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

Quicksilver.—At times a moderate business is encountered, but on the whole the situation is not very satisfactory. Prices of spot metal stand at about £9 15s. to £10 per bottle, net.

Tungsten Ore.—Sales are still on a most disappointing scale, but at one time prices rose to nearly 11s. per unit owing to the rapid advance in the price of silver. Subsequently they reacted to about 10s. 3d. c.i.f. for forward shipment from China.

Molybdenum Ore.—The undertone is fully steady, with 80 to 85% concentrates about 47s. 6d. to 50s. per unit c.i.f.

Graphite.—About £16 to £18 per ton c.i.f. is still quoted for 85 to 90% raw Madagascar flake and £15 to £17 c.i.f. for 90% Ceylon lumps.

Silver.—On March 1 spot bars were 17 1/16d. In the early part of the month China was inclined to buy as was also America, but India sold a little. The American financial crisis, accompanied as it was by an embargo on the export of silver, led to considerable speculative buying, which pushed prices up to 18¼d. for spot bars on March 11. Subsequently, as the American situation clarified and no inflation developed there, values developed an easier tendency, spot bars closing at 17⅜d. on March 31.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
March, 1932	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
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457
February	835,931	47,214	883,145
March	896,728	50,135	946,863

TRANSVAAL GOLD OUTPUTS.

	February.		March.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	106,500	£201,403	114,500	£211,780
City Deep	74,500	19,578	89,000	22,531
Cons. Main Reef	70,000	22,926	77,000	24,290
Crown Mines	262,000	80,581	291,000	88,790
Daggafontein	43,900	£106,572	46,000	£114,611
D'rb'n Roodepoort Deep	46,800	13,330	52,000	14,561
East Geduld	60,000	20,569	69,000	23,466
East Rand P.M.	150,000	37,874	164,000	41,000
Geduld	80,500	25,052	88,000	27,201
Geldenhuis Deep	71,000	15,232	76,500	15,849
Glynn's Lydenburg	7,000	2,545	7,760	2,493
Government G.M. Areas	192,000	£514,386	215,000	£555,421
Kleinfontein	46,200	9,539	53,800	10,100
Langlaagte Estate	75,000	£129,498	82,000	£137,113
Luipaard's Vlei	33,000	7,866	36,000	8,299
Modderfontein New	162,000	50,338	178,000	53,425
Modderfontein B	71,000	17,151	77,500	17,553
Modderfontein Deep	41,800	17,980	46,000	19,746
Modderfontein East	71,500	19,009	78,000	20,812
New State Areas	84,000	£241,388	94,000	£267,855
Nourse	67,200	18,276	72,000	18,678
Randfontein	235,000	£390,150	260,000	£428,905
Robinson Deep	92,000	25,197	100,000	27,023
Rose Deep	60,000	11,696	64,000	12,341
Simmer and Jack	79,000	19,226	90,200	21,096
Springs	75,500	£213,408	82,000	£217,918
Sub Nigel	35,000	33,363	38,000	35,519
Transvaal G.M. Estates	18,300	4,964	20,100	5,480
Van Ryn	48,000	£63,034	52,000	£63,601
Van Ryn Deep	70,000	£121,882	78,000	£130,666
West Rand Consolidated	88,000	£139,733	98,000	£149,557
West Springs	74,500	£102,213	82,500	£107,961
Witw'tersr'nd (Knights)	66,000	£67,537	69,000	£71,660
Witwatersrand Deep	45,400	14,617	47,000	15,722

Gold at 119s. per oz.

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.	£
December 1931	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	2,994,500	27 5	19 0	8 5	1,263,274
November	2,949,050	27 8	19 2	8 6	1,256,717
December	2,972,000	27 10	19 5	8 5	1,255,797
January, 1933	3,029,000	37 10	19 4	18 6	2,802,754
February	2,802,600	37 0	19 9	17 3	2,414,758

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
March 31, 1932	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
December 31	221,008	11,310	—	232,318
January 31, 1933	222,005	11,292	—	233,297
February 28	222,589	11,472	—	234,061
March 31	223,490	11,626	—	235,116

PRODUCTION OF GOLD IN RHODESIA.

	1930	1931	1932	1933
	oz.	oz.	oz.	oz.
January	46,121	45,677	42,706	48,656
February	43,385	42,818	45,032	47,661
March	45,511	42,278	47,239	—
April	45,806	43,776	46,487	—
May	47,645	43,731	46,854	—
June	45,208	44,118	48,441	—
July	45,810	44,765	47,331	—
August	46,152	43,292	49,254	—
September	46,151	42,846	50,198	—
October	45,006	44,260	50,416	—
November	44,351	44,516	48,082	—
December	46,485	50,034	52,096	—

RHODESIAN GOLD OUTPUTS.

	February.		March.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	23,600	8,706	25,600	9,527
Globe and Phœnix	6,042	5,239	—	—
Lonely Reef	10,200	2,079	11,000	2,130
Luiri Gold	—	—	—	—
Rezende	6,100	2,357	6,500	2,506
Sherwood Star	5,600	£7,010	6,400	£8,065
Wanderer Consolidated	14,400	3,287	15,900	3,672

WEST AFRICAN GOLD OUTPUTS.

	February.		March.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,911	216,398	—	—
Ashanti Goldfields	12,542	14,726	13,490	14,740
Taquah and Abosso	9,363	3,488	10,493	3,461

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
March, 1932	47,108	—	769
April	48,936	—	1,216
May	53,928	—	692
June	50,079	—	920
July	53,585	—	1,391
August	51,536	—	1,026
September	54,427	—	1,160
October	51,236	—	2,169
November	53,956	38,612†	4,386
December	52,282	9,133	4,602
January, 1933	45,755	—	—
February	47,281	—	—
March	47,083	—	—

† Period Jan.–Nov. 1932.

AUSTRALASIAN GOLD OUTPUTS.

	February.		March.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	4,766	5,923	5,477	5,732
Blackwater (N.Z.)	3,310	1,702*	3,860	1,823*
Boulder Persev'ce (W.A.)	6,624	11,676	—	—
Grt. Boulder Pro. (W.A.)	6,744	5,036*	—	—
Lake View & Star (W.A.)	34,429	64,438	—	—
Sons of Gwalia (W.A.)	9,704	14,426	12,104	16,055
South Kalgurli (W.A.)	7,897	12,790	10,124	15,322
Waihi (N.Z.)	18,947‡‡	5,636* 29,801†	18,797‡	5,972* 30,992†
Wiluna	30,285	8,029*	—	—

* Oz. gold. † Oz. silver. ‡ To Mar. 18. ‡‡ To Feb. 18.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	February.		March.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	9,540	5,015	9,400	5,564
Mysore	13,415	6,937	14,865	7,705
Nundydroog	18,098	13,613†	19,481	12,811*
Ooregum	11,750	3,866	11,765	4,221

* 1,127 oz. from 1,130 tons Balaghat ore. † 1,155 oz. from 1,340 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	February.		March.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	159,692*d*	—	—
Chosen Corp. (Korea)	8,930	17,104	—	—
Frontino Gold (C'lbia)	3,320	15,445	4,370	19,990
Fresnillo	75,808	281*d*‡	—	—
New Goldfields of Venezuela	8,110	2,262*	8,527	2,324*
Oriental Cons. (Korea)	—	153,519*d*	—	67,465*d*
St. John del Rey (Brazil)	—	38,500	—	38,500
Santa Gertrudis (Mexico)	16,645	6,027*d*‡	—	—
Viborita	—	—	—	—
West Mexican Mines	—	—	—	—

d Dollars. * Oz. gold. ‡ Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1932	1,437	January, 1933	2,312
August	1,164	February	2,154
September	1,123	March	—
October	2,273	April	—
November	2,242	May	—
December	1,590	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Ayer Hitam	113	—	—
Batu Caves	43	27	—
Changkat	58	60	55
Gopeng	—	—	72½*
Hongkong Tin	—	—	105*
Idris Hydraulic	17¾	18	—
Ipoh	133½	55¼	—
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	150	—	173
Kent (F.M.S.)	—	—	—
Killinghall	—	—	86¾*
Kinta	—	—	34¼*
Kinta Kellas	—	—	38½*
Kramat Tin	78	70	78
Kuala Kampar	—	—	—
Kundang	—	—	—
Lahat	14½	11	7¼
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	80¼	81	—
Malim Nawar	—	—	—
Pahang	78	78	78
Penawat	52¼	48½	39
Pengkalen	—	—	67*
Petaling	—	—	151
Rahman	25	25	—
Rambutan	—	—	—
Rantau	30	21	—
Rawang	18	33	42
Rawang Concessions	42	29	16
Renong	22½	25¼	23½
Selayang	—	—	—
Southern Kampar	93	78½	—
Southern Malayan	53½	53½	51¼
Southern Perak	41¾	15¾	—
Southern Tronoh	18	18	18
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	38½	53½	—
Taiping	9	9	—
Tanjong	—	—	—
Tekka	—	—	39*
Tekka Taiping	—	—	65*
Temoh	—	—	—
Tronoh	39	39	39
Ulu Klang	—	—	—

* 3 months to Mar. 31.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Anglo-Nigerian	15	18	17½
Associated Tin Mines	104½	100½	106
Baba River	4	3	3
Batura Monguna	—	—	—
Bisichi	16	20	—
Daffo	—	—	—
Ex-Lands	—	—	—
Filani	—	—	—
Jantar	10	10	—
Jos	7¾	7¾	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	12¾	11	—
Kaduna Prospectors	6¼	6	—
Kassa	3	3	3
London Tin	76	76	75
Lower Bisichi	3	3	—
Naraguta Extended	—	—	—
Nigerian Consolidated	4	5	—
Offin River	—	—	—
Ribon Valley	10	9	10
Tin Fields	—	—	—
United Tin Areas	10	9	9
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Anglo-Burma (Burma)	38	23	—
Aramayo Mines (Bolivia)	116	123	99
Bangrin (Siam)	43	—	51½
Beralt	21*	24*	—
Consolidated Tin Mines (Burma)	90	82	73
East Pool (Cornwall)	46½	45	—
Fabulosa (Bolivia)	39	34	—
Geevor	—	—	55
Kagera (Uganda)	25	21	—
Kamra	—	—	—
Malaysiam Tin	14½	14¼	14¼
Mawchi	224*	218*	—
Patino	—	—	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	137¾	—	118½
South Crofty	50	49½	—
Tavoy Tin (Burma)	69	38¼	47½
Tongkah Harbour (Siam)	35	50	35
Toyo (Japan)	56	54¼	68½
Zaaiplaats	15	—	—

* Tin and Wolfram.

COPPER LEAD, AND ZINC OUTPUTS.

		Feb.	Mar.
Britannia Lead	Tons refined lead	5,224	—
	Oz. refined silver	168,735	—
Broken Hill South	Tons lead conc.	4,763*	—
	Tons zinc conc.	5,292*	—
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	520,160	520,975
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	360	400
	Tons yellow metal	450	460
Messina	Tons copper	845	796
Mount Isa	Tons lead bullion	3,276	—
Mount Lyell	Tons concentrates	2,850	2,313†
North Broken Hill	Tons lead conc.	4,870	4,900
	Tons zinc conc.	4,550	4,790
Rhodesia Broken Hill	Tons Zinc	1,420	1,550
	Tons V_2O_5 conc.	20	20
Roan Antelope	Tons blister copper	—	—
Sulphide Corporation	Tons lead conc.	1,476*	—
	Tons zinc conc.	2,164*	—
Trepca	Tons lead conc.	4,305	4,952
	Tons zinc conc.	6,379	6,721
Zinc Corporation	Tons lead conc.	5,535*	—
	Tons zinc conc.	4,714*	—

* To March 11. † To March 22.

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

		Jan.	Feb.
Iron Ore	Tons	163,583	210,635
Manganese Ore	Tons	7,102	4,929
Iron and Steel	Tons	69,472	77,959
Copper and Iron Pyrites	Tons	17,875	30,666
Copper Ore, Matte, and Prec.	Tons	735	3,103
Copper Metal	Tons	12,217	8,634
Tin Concentrate	Tons	2,127	1,313
Tin Metal	Tons	140	320
Lead Pig and Sheet	Tons	22,125	19,835
Zinc (Spelter)	Tons	4,061	5,631
Zinc Sheets, etc.	Tons	1,323	1,111
Zinc Oxide	Tons	41	21
Zinc Ore and Conc.	Tons	12,006	2,126
Aluminium	Cwt.	8,935	5,012
Mercury	Lb.	171,957	135,743
White Lead	Cwt.	5,170	5,158
Barytes, ground	Cwt.	20,345	25,092
Asbestos	Tons	1,114	910
Boron Minerals	Tons	1,413	1,064
Borax	Cwt.	4,722	7,700
Basic Slag	Tons	—	1,000
Superphosphates	Tons	1,200	4,245
Phosphate of Lime	Tons	32,201	20,919
Mica	Tons	184	130
Tungsten Ores	Tons	298	296
Sulphur	Tons	7,952	5,667
Nitrate of Soda	Cwt.	2,001	120
Potash Salts	Cwt.	113,019	128,077
Petroleum: Crude	Gallons	34,085,889	25,157,778
Lamp Oil	Gallons	16,005,910	17,360,876
Motor Spirit	Gallons	83,120,905	66,960,656
Lubricating Oil	Gallons	8,109,101	3,265,040
Gas Oil	Gallons	9,687,889	8,862,734
Fuel Oil	Gallons	43,584,633	46,168,593
Asphalt and Bitumen	Tons	10,078	9,251
Paraffin Wax	Cwt.	74,026	90,925

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Jan.	Feb.	Mar.
Anglo-Ecuadorian	16,117	14,780	16,011
Apex Trinid. d	45,190	44,500	49,030
Attock	1,533	1,259	1,421
British Burmah	3,911	4,241	5,091
British Controlled	43,903	41,870	—
Kern Mex	832	760	—
Kern River (Cal.)	3,346	3,244	—
Kern Romana	77	74	—
Kern Trinidad	1,903	2,641	—
Lobitos	23,071	20,290	21,454
Phœnix	65,719	59,338	65,388
St. Helen's Petroleum	3,967	3,795	—
Steaua Romana	90,564	81,733	—
Tampico	2,219	2,091	—
Tocuyo	1,219	1,073	1,153
Trinidad Leaseholds	28,550	28,600	31,650

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Mar. 9, 1933.			Apr. 8, 1933.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		10	6		11	0
Anglo-Egyptian B	1	10	0	1	10	0
Anglo-Persian 1st Pref.	1	7	6	1	7	3
" " Ord.	1	16	9	1	18	0
Apex Trinidad (5s.)	1	0	6	1	3	9
Attock		7	6		10	0
British Burmah (8s.)		4	0		4	3
British Controlled ($5)		3	6		4	3
Burmah Oil	2	17	6	2	18	9
Kern River Cal. (10s.)		2	0		3	0
Lobitos, Peru	1	11	3	1	15	0
Mexican Eagle, Ord. (4 pesos)		6	6		6	9
" " 8% Pref. (4 pesos)		5	9		5	9
Phœnix, Roumanian		8	3		10	0
Royal Dutch (100 fl.)	16	15	0	16	15	0
Shell Transport, Ord.	2	2	6	2	3	0
" " 5% Pref. (£10)	11	7	6	11	7	6
Steaua Romana		7	0		9	6
Trinidad Leaseholds	2	7	6	2	13	9
United British of Trinidad (6s. 8d.)		4	0		4	9
V.O.C. Holding	1	8	0	1	11	3

PRICES OF CHEMICALS. April 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.	1	0	9
" " 80%	"	1	18	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 (Mono- and Di-)	"	58	0	0
" Sulphate, 20·6% N.	"	6	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
" Sulphide, golden	"			9
Arsenic, White (foreign)	per ton	20	0	0
Barium, Carbonate (native), 94%	"	4	10	0
" Chloride	"	10	10	0
Barytes	"	8	5	0
Benzol, standard motor	per gal.		1	6½
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	"	16	10	0
Boric Acid	"	26	10	0
Calcium Chloride, solid, 70/75%	"	5	15	0
Carbolic Acid, crude 60's	per gal.		3	0
" " crystallized, 40°	per lb.			11
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.			9½
Copper Sulphate	per ton	14	15	0
Creosote Oil (f.o.b. in Bulk)	per gal.			3¾
Cresylic Acid, 98–100%	"		1	2
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine Resub. B.P. (28 lb. lots)	"		14	11
Iron, Nitrate 80° Tw.	per ton	6	0	0
" Sulphate	"	1	15	0
Lead, Acetate, white	"	31	10	0
" Nitrate (ton lots)	"	27	10	0
" Oxide, Litharge	"	25	10	0
" White	"	37	10	0
Lime, Acetate, brown	"	9	5	0
" " grey, 80%	"	13	5	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 ton	48	0	0
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	10	0
" Hydrate (Caustic) 88/90%	per ton	40	0	0
" Nitrate	"	30	0	0
" Permanganate	per lb.			8½
" Prussiate, Yellow	per ton	75	0	0
" " Red	per lb.		2	0
" Sulphate, 90%	per ton	10	10	0
Sodium Acetate	"	23	10	0
" Arsenate, 45%	"	23	5	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.			4
" Carbonate (Soda Ash), 58%	per ton	6	0	0
" " (Crystals)	"	5	2	6
" Chlorate	"	32	0	0
" Cyanide, 100% NaCN basis	per lb.			8
" Ethyl Xanthate	per 100 kilos	7	1	6
" Hydrate, 76%	per ton	14	0	0
" Hyposulphite, comml.	"	9	2	6
" Nitrate (refined)	"	8	10	0
" Phosphate, comml.	"	12	0	0
" Prussiate	per lb.			4¾
" 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	9	15	0
" Roll	"	9	15	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	61	0	0
Tin Crystals	per lb		1	0
Titanous Chloride	"			10½
Zinc Chloride	per ton	9	10	0
" Dust, 90/92%	"	20	0	0
" Oxide (White Seal)	"	35	0	0
" Sulphate	"	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:

	Mar. 9, 1933. £	s.	d.	Apr. 8, 1933. £	s.	d.
SOUTH AFRICA:						
Brakpan	5	8	9	6	2	6
City Deep	1	5	0	1	8	9
Consolidated Main Reef	2	0	0	2	7	6
Crown Mines (10s.)	7	17	6	9	1	9
Daggafontein	3	5	0	4	0	9
Durban Roodepoort Deep (10s.)	1	14	3	2	3	0
East Geduld	4	10	0	5	3	9
East Rand Proprietary (10s.)	1	3	9	1	5	6
Geduld	5	4	3	5	17	6
Geldenhuis Deep	1	4	3	1	6	3
Glynn's Lydenburg	1	1	9	1	6	6
Government Gold Mining Areas (5s.)	2	0	0	2	5	0
Grootvlei	1	17	6	2	10	0
Langlaagte Estate	1	7	6	1	6	9
Luipaard's Vlei (2s.)		8	3		9	6
Modderfontein, New (10s.)	3	1	9	3	11	3
Modderfontein B (5s.)		19	3		19	3
Modderfontein Deep (5s.)		17	3		18	3
Modderfontein East	2	12	6	3	0	0
New Kleinfontein	1	7	6	1	14	3
New State Areas	2	13	9	3	0	9
Nourse	1	18	0	2	0	9
Randfontein	2	8	3	2	14	0
Robinson Deep A (1s.)		13	9		13	9
" " B (7s. 6d.)	1	6	9	1	13	9
Rose Deep		18	0		19	0
Simmer and Jack (2s. 6d.)		6	9		7	9
Springs	4	13	0	5	10	9
Sub Nigel (10s.)	7	5	0	8	16	9
Van Ryn	1	3	9	1	5	9
Van Ryn Deep	1	11	3	1	16	3
Village Deep (9s. 6d.)		1	4		1	6
West Rand Consolidated (10s.)	1	0	0	1	2	6
West Springs	1	10	9	1	16	3
Witwatersrand (Knights)	1	1	3	1	0	9
Witwatersrand Deep	1	3	9	1	6	9
RHODESIA:						
Cam and Motor	2	1	3	2	5	0
Globe and Phœnix (5s.)		16	0		18	6
Lonely Reef		10	0		10	0
Luiri Gold (5s.)			9			9
Rezende (17s. 6d.)	1	6	3	1	8	9
Sherwood Starr (5s.)		11	6		13	0
Wanderer		17	6		16	3
GOLD COAST:						
Ariston (2s. 6d.)		6	9		6	9
Ashanti (4s.)	1	14	9	1	15	3
Taquah and Abosso (4s.)		9	0		10	3
AUSTRALASIA:						
Associated Gold (4s.), W.A.		2	9		3	0
Golden Horseshoe (3s.), W.A.		3	9		3	9
Great Boulder Propriet'y (2s.), W.A.		6	6		6	6
Lake View and Star (4s.), W.A.		17	0		19	0
Sons of Gwalia (10s.), W.A.		15	3	1	0	0
South Kalgurli (10s.), W.A.	1	3	3	1	6	3
Waihi (5s.), N.Z.		17	0		18	3
Wiluna Gold, W.A.	1	19	6	1	19	3
INDIA:						
Champion Reef (10s.)		19	3	1	2	0
Mysore (10s.)		12	6		14	3
Nundydroog (10s.)	2	0	0	2	5	6
Ooregum (10s.)		6	3		7	0
AMERICA:						
Camp Bird (2s.), Colorado			10			4
Exploration (10s.)		2	0		2	3
Frontino and Bolivia, Colombia	1	6	3	1	6	3
Mexican Corporation (10s.), Mexico		5	0		5	0
New Goldfields of Venezuela (5s.)		4	6		4	6
St. John del Rey, Brazil	1	2	6	1	3	0
Santa Gertrudis, Mexico		6	3		5	0
Viborita (5s.), Colombia		3	6		3	9
MISCELLANEOUS:						
Chosen, Korea		7	0		10	0
New Guinea		4	0		4	9

COPPER:

	£	s.	d.	£	s.	d.
Bwana M'Kubwa (5s.), Rhodesia		3	6		5	0
Esperanza		6	3		6	3
Indian (2s.)		1	9		1	9
Loangwa (5s.), Rhodesia		1	6		1	9
Mason and Barry		10	0		11	3
Messina (5s.), Transvaal		6	0		7	0
Mount Lyell, Tasmania		15	6		15	3
Namaqua (£2), Cape Province		2	0		3	6
Rhodesia-Katanga		10	0		10	0
Rio Tinto (£5), Spain	15	10	0	14	15	0
Roan Antelope (5s.), Rhodesia		12	0		14	9
Tanganyika Concessions		17	6		16	9
Tharsis (£2), Spain	2	18	9	2	18	9

LEAD-ZINC:

	Mar. 9, 1933. £	s.	d.	Apr. 8, 1933. £	s.	d.
Amalgamated Zinc (8s.), N.S.W.		7	6		7	6
Broken Hill Proprietary, N.S.W.	1	1	9	1	3	9
Broken Hill, North, N.S.W.	2	12	6	2	11	3
Broken Hill, South, N.S.W.	1	15	0	1	13	9
Burma Corporation (10 rupees)		11	3		11	0
Electrolytic Zinc Pref., Tasmania		10	6	1	0	3
Mount Isa, Queensland		8	0		7	6
Rhodesia Broken Hill (5s.)		1	9		1	9
San Francisco (10s.), Mexico		9	3		8	0
Sulphide Corporation (15s.), N.S.W.		6	6		6	0
ditto, Pref.		8	6		8	3
Trepca (5s.), Yugoslavia		9	0		8	6
Zinc Corporation (10s.), N.S.W.	1	0	9	1	0	0
ditto, Pref.	3	6	3	3	7	6

TIN:

	£	s.	d.	£	s.	d.
Aramayo Mines (25 fr.), Bolivia		11	3		11	3
Associated Tin (5s.), Nigeria		4	0		4	3
Ayer Hitam (5s.), Malay		11	3		11	6
Bangrin, Siam		11	3		11	6
Bisichi (10s.), Nigeria		4	9		5	3
Consolidated Tin Mines of Burma		2	9		2	9
East Pool (5s.), Cornwall			10½			9
Ex-Lands Nigeria (2s.)		1	0		1	0
Geevor (10s.), Cornwall		2	6		3	0
Gopeng, Malay	1	7	6	1	7	6
Hongkong (5s.), Malay		12	0		12	0
Idris (5s.), Malay		4	3		5	0
Ipoh Dredging (16s.), Malay		13	6		14	3
Kaduna Prospectors (5s.), Nigeria		5	0		5	0
Kaduna Syndicate (5s.), Nigeria		12	6		11	3
Kamunting (5s.), Malay		6	0		6	6
Kepong, Malay		6	3		6	3
Kinta (5s.), Malay		4	0		4	0
Kinta Kellas (5s.), Malay		3	0		4	0
Kramat Pulai, Malay		13	9		14	6
Kramat Tin, Malay	1	6	0	1	8	6
Lahat, Malay		—			—	
Malayan Tin Dredging (5s.)		16	6		17	9
Naraguta, Nigeria		8	9		8	9
Pahang Consolidated (5s.), Malay		4	3		4	3
Penawat ($1), Malay		1	3		1	0
Pengkalen (5s.), Malay		8	0		7	6
Petaling (2s. 4d.), Malay		10	6		10	6
Rambutan, Malay		4	0		4	0
Renong Dredging, Malay		14	9		14	6
Siamese Tin (5s.), Siam		7	3		8	6
South Crofty (5s.), Cornwall		2	0		2	0
Southern Malayan (5s.)		10	6		10	9
Southern Perak, Malay	1	5	0	1	5	0
Southern Tronoh (5s.), Malay		4	3		4	6
Sungei Besi (5s.), Malay		8	9		9	0
Sungei Kinta, Malay		8	0		8	9
Tanjong (5s.), Malay		5	9		5	6
Tavoy (4s.), Burma		4	6		4	3
Tekka, Malay		8	9		8	0
Tekka Taiping, Malay		7	6		8	0
Temoh, Malay		9	6		10	0
Toyo (2s. 6d.), Japan		3	6		2	6
Tronoh (5s.), Malay		14	3		14	3

DIAMONDS:

	£	s.	d.	£	s.	d.
Consol. African Selection Trust (5s.)		15	6		15	6
Consolidated of S.W.A. (10s.)		4	0		5	3
De Beers Deferred (£2 10s.)	4	15	0	4	11	3
Jagersfontein	1	2	6	1	2	6
Premier Preferred (5s.)	1	5	0	1	2	6

FINANCE, Etc.:

	£	s.	d.	£	s.	d.
Anglo American Corporation (10s.)		16	0	1	0	3
Anglo-Continental (10s.)		4	6		3	6
Anglo-French Exploration		18	0	1	0	0
Anglo-Oriental (5s.)		6	0		6	3
ditto, Pref.		8	9		8	9
British South Africa (15s.)		15	6		16	6
Central Mining (£8)	15	0	0	16	7	6
Consolidated Gold Fields	2	2	6	2	8	0
Consolidated Mines Selection (10s.)		9	0		12	9
Fanti Consols (8s.)		8	3		8	3
General Mining and Finance	1	12	6	1	18	9
Gold Fields Rhodesian (10s.)		4	3		5	0
Johannesburg Consolidated	1	19	6	2	3	9
London Tin Corporation (10s.)		8	6		9	3
Minerals Separation	3	2	6	3	5	0
Mining Trust		4	3		3	9
National Mining (8s.)			3			3
Rand Mines (5s.)	5	2	6	5	12	6
Rand Selection (5s.)		14	6		17	9
Rhodesian Anglo American (10s.)		9	6		11	6
Rhodesian Selection Trust (5s.)		4	9		5	9
Rhokana Corp.	4	5	0	5	2	6
Tigon (5s.)		3	3		2	3
Union Corporation (12s. 6d.)	3	8	9	3	18	9
Venture Trust (6s. 8d.)		6	6		6	6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

DEEP MINING ON THE WITWATERSRAND

A paper by W. C. Coe and J. P. Rees discussing some special features of deep-level mining on the Witwatersrand, illustrated by practice at the Robinson Deep mine, appears in the *Journal* of the South African Institution of Engineers and full extracts from their paper are given here. The authors state that their objects in writing the notes were—

(1) to discuss a few of the problems which arise as advance in depth is made;

(2) to state how these problems have been and are being dealt with at the Robinson Deep; and

(3) to enable some idea to be formed of the probable maximum depth at which mining operations can be carried out.

The question of the probable maximum depth of operations at a mine such as this is an important one, for a decision on the point furnishes one of the factors used in the determination of the estimated life of the mine. As an illustration of this point it may be mentioned that, in the case of the Turf section, depletion takes place at the rate of approximately 200 ft. vertically per annum. In the case of the Turf section the programme of work which has been laid down will entail working at a depth of 8,500 ft. and no extreme changes in present methods are anticipated in carrying it out.

As a result of the study of the figures contained in these notes, it appears that it will be possible to work to a depth of 10,000 ft. To mine at this depth it may be necessary to introduce special methods, such as—

(1) the sinking of deep vertical shafts;

(2) special provision for the support of workings; and

(3) the reconditioning of the mine air by means of refrigeration and dehumidification.

The depth and temperature figures quoted in the notes were those existing at the time when the notes were written. Since then there has been an advance in depth and the figures at date are as follows: The deepest point is 8,006 ft. below the collar of the shaft and the rock temperature at this point is 101·5° F.

The following are brief notes on some of the features connected with underground work in the Robinson Deep mine. As an indication of the extent of operations the following round figures are given:—

Tons hoisted per month . . .	117,000
Tons milled per month . . .	100,000
Development footage per month . .	5,000
Average number of whites working underground	390
Average number of natives working underground	6,100

The mine is divided into two sections, Chris and Turf. The Turf section is the deeper and, as the object of this paper is to emphasize the features connected with depth, most of the notes relate to that section. At the Turf section the deepest point is 8,006 ft. below the collar of the shaft.

SHAFTS.—The Turf section is served by—

(1) A 7-compartment vertical shaft, 42 ft. 6 in. by 6 ft. 6 in., 4,060 ft. deep.

(2) A 6-compartment main inclined shaft, 36 ft. 5 in. by 6 ft. 7 in., 3,775 ft. long.

(3) A pair of sub-inclined shafts (each 3 compartments). East, 15 ft. 1 in. by 6 ft. 7 in.; and West, 16 ft. 9 in. by 6 ft. 7 in.; 2,967 ft. and 3,265 ft. respectively.

The Chris section is served by—

(1) A 7-compartment vertical shaft, 42 ft. by 6 ft. 6 in., 4,254 ft. deep.

(2) A 7-compartment sub-vertical shaft, 42 ft. by 6 ft. 6 in., 2,150 ft. deep.

(3) A pair of sub-inclined shafts (each 3 compartments). East, 16 ft. 10 in. by 6 ft. 6 in.; and West, 14 ft. 8 in. by 6 ft. 6 in.; 1,791 ft. and 1,879 ft. long respectively.

The sinking of all four sub-inclined shafts is proceeding. The shaft dimensions, which are inside timbers between wall and end plates, are given in order to enable an idea to be formed of the areas of the intake airways. The main inclined shaft, Turf section, was laid out in the foot-wall so as to permit of direct tipping into same from the sub-inclined shafts. The sub-inclined shafts, both sections, were set off in the foot-wall 100 ft. normally below the reef.

DEVELOPMENT.—Levels are spaced 300 ft. apart along the dip. Foot-wall drives are driven on each level at a distance of 50 ft. normally beneath the reef. From the foot-wall drives cross-cuts to reef are spaced at 500-ft. intervals. Reef driving is done on each level in addition to the foot-wall drives. Winze-raise connexions are put through from level to level at distances apart of approximately 500 ft. Ore pass systems are constructed as required, usually to serve three levels. An effort is made to carry drives and cross-cuts to dimensions of 7 ft. high by 6½ ft. wide, as larger dimensions result in trouble caused by falls of hanging. Even with the dimensions mentioned it is found that scaling takes place, particularly from the north (up dip) side. Cross-cuts from shaft stations to reef are made wider in order to facilitate the passage of the intake air and to provide room for double tramming tracks.

The particular feature pertaining to depth under this heading is the placing of drives in the foot-wall. This is of the greatest importance in a very deep mine and, in the author's opinion, is essential even if for ventilation purposes alone.

STOPING.—

The average reef width is . . .	30·8 in.
The average channel width is . .	41·8 in.
The average stope width is . . .	61·1 in.
The average dip of reef is . . .	33½ deg.

South reef is stoped in addition to main reef leader. The amount of main reef stoped is negligible.

Stoping is done by ordinary methods with the faces set back from the line of dip at an angle of approximately 25°. This angle permits the support to be kept up to the face, facilitates the handling of the broken ground, and is conducive to safety. A length of back of 300 ft. has been found by experience to be most suitable. Settlement of hanging makes conditions difficult if backs are over 300 ft. Furthermore, shovelling conditions are arduous and the rock hangs up if chutes are too long. Longer backs have been tried, but have proved to be inefficient, as in such cases it has been necessary to put in intermediate tracks, which system involves a double handling of the broken ground. Supervision is better over the 300 ft. length of back.

The particular feature pertaining to depth under this heading is the weight on the stope face. This weight is shown by (1) the fracture planes, which develop immediately and which follow the line of the face; and (2) by the rapid settlement of the hanging on to the packs and props. Props put in on one shift are frequently found to be broken on the following shift. Advantage is taken of this weight by, whenever possible, working stope faces on alternate days. South reef is usually stoped after main reef leader. This sequence is due to the fortuitous circumstance that, on account of the erratic distribution of values, south reef is usually developed subsequently to main reef leader.

SHOVELLING AND TRAMMING.—Hand shovelling and tramming methods are used in dealing with rock from development and shaft sinking ends. This work is done on night shift. In stopes the broken reef is shovelled into iron chutes laid on the foot-wall. It gravitates down the chute lines into stope boxes which control the loading into 1½-ton cars. It is then hand-trammed either direct to the shaft, to an ore pass, or to a mechanical haulage as the case may be. Haulages are of two types: endless rope or battery locomotive.

WINDING.—There are three stages of winding. Skips of various capacities are used, ranging from 4 tons to 8 tons. All hoists are electrically-driven, except those at the Chris shaft, where steam is used. The Turf vertical shaft rock hoists are of the Whiting type. The sub-inclined shafts are in pairs, there being a distance of 80 ft. between the individual members of each pair. Tips are so arranged in the cross-cuts off the sub-inclined shafts that the rock tipped is fed to either member of the pair of shafts. The sub-inclined shafts are arranged so that the rock hoisted in either is tipped directly into the corresponding reef or waste bins on the main inclined shaft. In turn the rock hoisted up the main inclined shaft is tipped directly into the bins on the vertical shaft. Loading boxes are usually spaced three levels apart.

HANDLING OF MEN AND MATERIAL.—It will be appreciated that, in the case of a deep mine, the handling of men and material has to be done expeditiously. At the Turf section persons travel an average distance of 2¼ miles from the surface to the working places. Facilities have been installed for the quick changing of skips and cages. The cages in use are of various capacities, ranging from 48 to 72 persons.

At the change of shifts, skips are taken off and cages substituted in practically all winding compartments. The lowering of the main shift is done in about 1½ hours and the raising of same in a similar time. The travelling of persons is governed by a strictly observed time-table.

Special trolleys for timber, drill steel and explosives, etc., are used so as to eliminate, as far as possible, rehandling between the surface and the working place. Trailers for conveying material are attached beneath the skips. They are passed along the cross-cut which connects the main inclined and sub-inclined shafts and, via a transfer dock, are changed from the one shaft to the other.

PUMPING.—Electrically driven, high-lift centrifugal pumps are used for dealing with settled water and reciprocating pumps for unsettled water. Small compressed-air-driven pumps are used at the faces of the sinking shafts. The mine water is neutralized and settled and a certain proportion is lifted to suitably placed storage sumps, from which the general underground service is supplied. The remainder is pumped to the surface. Pumping is done through four stages. Each stage consists of a lift of approximately 2,000 ft. vertically.

On specific shifts the settled mud is agitated and pumped by means of reciprocating pumps to the surface. The average quantity of water pumped per month for the whole mine is approximately 66 million gallons. Of this quantity about 19 million gallons per month is pumped to the surface.

FIRE SERVICE.—The long line of timbered inclined shafts constitutes a potential danger from fire. A high-pressure fire service, with hydrants at each level, has been installed throughout the inclined shafts. Suitable equipment is kept on various stations in the shape of hoses, etc., also special equipment, including hand pumps for dealing with fires in stopes or elsewhere. Detailed instructions are given to certain parties concerned so as to ensure prompt measures being taken in case of an outbreak of fire. Smoking is prohibited on inclined shaft stations and whilst travelling in the shafts. The mine has a rescue team, which is equipped and trained to deal with outbreaks of fire or serious cases of gassing.

SANITATION AND HEALTH.—The only particular feature as regards sanitation is that which concerns the use of salt as a means of preventing the occurrence of ankylostomiasis (commonly called hookworm). Salt is liberally applied at main stations and latrines, whilst cages are sprinkled with salt and washed daily. Miners are provided with a supply of salt at their boxes, which they use as required. The incidence of ankylostomiasis amongst whites has almost ceased as a result of these precautions. This disease is introduced to the mines by natives, particularly those from hot regions, such as the East coast.

As greater depths are reached the consequent hot humid atmosphere constitutes a condition which is entirely favourable to the cultivation of bacteria, with the result that the workers need to exercise considerable care in order to keep free of the various affections to which they are liable. Wounds very readily become septic and even the slightest cut needs prompt attention. White men frequently suffer from boils. There has appeared a further troublesome disease—yaws. It appears, with

PLAN OF THE WORKINGS AT THE ROBINSON DEEP MINE, SHOWING THE VENTILATION SCHEME.

a few exceptions, amongst underground natives only.

An additional difficulty which arises as the result of working at great depth is the liability to heat stroke. Several precautionary measures are in force with the object of minimizing this danger. The principal one is, of course, the maintenance of effective ventilation. Whilst high temperature alone does not constitute an unhealthy condition, it is difficult to avoid the danger of heat stroke when a high humidity condition of the atmosphere is combined with high temperature. As would be expected, very few cases of heat stroke occur amongst white men, for their work is largely of a supervisory nature. The main precautions taken against heat stroke, as applying to natives, are :—

(1) Special feeding arrangements to ensure that the native has a good meal before going on shift.

(2) Probationary periods during which the native is acclimatized by being placed on light work under hot and humid conditions.

(3) Special provisions for dealing with natives *ex* hospital.

Instructions are in force for the treatment of heat stroke should it occur and in this connexion it may be mentioned that the immediate subcutaneous injection of the drug lobelin has been found to be most efficacious. It is essential that, as soon as distress is evident, the patient shall be removed without exertion on his part.

The critical conditions under which heat stroke is liable to occur amongst acclimatized persons appear to be those where the air, at a temperature of 92° F. wet and dry bulb, is moving slowly and where they are working under these conditions in a confined space or in cramped positions.

When working under very hot conditions the loss of salt from the body caused by free perspiration is considerable. To counteract this a supply of drinking water is provided, to which has been added a small proportion of salt and, in order to make it palatable, a modicum of lime juice. Observations made at the Turf section show that the native labourer loses approximately 5 lb. in weight during the working shift and regains same before the next shift. If no water is taken the loss in weight may become as high as 8 or 9 lb. Some difficulty has been experienced in getting the natives to take the food provided for them before going underground, for (1) the native goes on shift very early and is usually hurried, and (2) is unaccustomed at his kraal to this early meal. In many cases of heat stroke it has been found that the sufferer had not eaten well before going underground.

When returning to the surface at the end of the shift the workers are subjected to a wide range in temperature, with consequent danger to health. To guard against this, a system of doors has been installed between the main inclined and vertical shafts, which enables the shift to pass through without being unduly exposed to the high velocity cold intake current.

Accidents.—In the matter of accidents a deep mine is at a disadvantage. In addition to the danger of falls of hanging, portions of the working face scale off, sometimes violently, on account of pressure or cooling effect, or both. The excessive heat and humidity cause the worker to discard his clothing, with the result that the bare skin is exposed and is then rendered more liable to cuts or abrasions. Hot and moist conditions engender a feeling of lassitude, which means that the worker becomes less alert and consequently fails to avoid danger in the normal manner.

Support of Workings.—The inclined shafts are carried in the foot-wall and the overlying reef is stoped in order to ease the pressure on them. At greater depths it has been found advantageous to sink a pair of inclined shafts each of three compartments rather than one inclined shaft of five compartments. This method ensures better control of the hanging-wall and limits the possibilities of interruption to hoisting operations which may be caused by rock falls.

Drives and cross-cuts are supported, where necessary, by ordinary timber sets. It has been found that sets, although blocked in the ordinary manner, have been shaken down when severe bursts occur. In order to overcome this difficulty sets are stayed the one from the other by means of struts between the respective cap pieces at the points where the caps rest on the supporting legs. The portions of foot-wall drives beneath remnants are timbered in this manner.

In certain places where foot-wall drives pass through dyke, it is necessary to widen the drives and construct packs on the north and south sides. This precaution minimizes the danger of the dyke bursting into such drives. Reef drives are protected by taking a cut off the reef along the north and south sides, to the extent of at least 12 ft. in each case. Rows of packs are then established above and below the drives. This precaution prevents the fracture of the hanging, which invariably follows the face, from affecting the drive. Large excavations in the foot-wall, such as engine rooms and pump stations, etc., are, unless situated well in the foot-wall, protected by stoping the reef above. In certain cases this policy is carried out even if the overlying rock is dyke.

Stopes are supported by waste-filled lagging packs, waste-filled wire packs, and mat packs, according to circumstances. Waste-filled packs are spaced 5 ft. apart along the strike and 6 ft. apart along the dip, with the one line of packs not directly opposite the other. Mat packs are used in stopes of narrow channel widths and little exterior waste. The area supported at the Turf section has been found by actual measurement to average approximately 27%.

Packs are kept well up to the face and are supplemented by props with head-boards. During normal stoping operations, with the exercise of care, no abnormal trouble is experienced. But when a block of ground has been worked to the extent that only a small portion remains, it becomes necessary to observe special precautions. Such small portions of ground are termed remnants. A meeting between the manager and senior underground officials is held monthly, at which the working of current remnants and the question of potential remnants are discussed. On its being decided that a portion of ground is to be treated as a remnant, the fact is recorded in writing. A schedule of arrangements for dealing with remnants is then immediately put into effect. The schedule comprises special methods of working and safety precautions, such as :—

(1) Entry of plan and sundry details into the Remnants Record Book.

(2) Submission of monthly reports, including observations of changes in nature of working face and hanging, increase in weight, etc.

(3) Methods of working, such as direction of face, special arrangements for support, labour and supervision, and type of holes and strength of explosives.

(4) Safety precautions, including those pertaining to travelling ways, gang book system for roll-call if necessary, wearing of hard hats, protective stulls and barricades, etc.

Rockbursts.—One of the chief difficulties attached to deep mining is that of rockbursts. Rockbursts usually occur during the stoping of remnants and in excavations immediately beneath same. Despite the fact of repetition, the following statement of the precautions taken to minimize the effects of rockbursts is given : The protection of :—

(1) Vertical shafts : By leaving intact an area of approximately 1,000 ft. by 1,000 ft. where the shafts pass through the reef.

(2) Inclined shafts : By stoping the overlying reef and by stripping the hanging and sides clear of the shaft timbers.

(3) Reef drives : By north and south siding and by rapidly stoping the bottom points of remnants.

(4) Foot-wall drives : By suitable timber supports combined, where necessary, by the widening of the drive with subsequent packing.

(5) Engine rooms, rope races, pump chambers, etc. : By stripping the hanging and sides clear of the supporting structures.

(6) Stopes : By carrying out special arrangements for the stoping of remnants, as previously mentioned.

Ventilation.—When considering the working of a deep mine it is obvious that the question of ventilation is of the greatest importance. Consequently, this feature warrants considerable attention. The following are main principles

which it is necessary to observe in dealing with the ventilation of the mine :—

(1) To get as much of the air entering the shaft at the surface to the lowest levels.

(2) To split the air east and west on two or three bottom levels only.

(3) To deliver the air to the boundary by means of foot-wall drives only.

(4) To reduce the number of stopes through which the air passes in series to two or three only.

(5) To ventilate development work by a combination of compressed air and booster fans.

(6) To make ample provision for the exit of the return air.

The necessary requirements to carry out these principles and the results which have been obtained, as applying to the Turf section, are as follows :—The fan is of the Walker indestructible type. It is a double-entry fan with eight blades or paddles, is 14 ft. 9 in. in diameter and is 6 ft. wide. It is direct-coupled to an 875 horse-power alternating current motor running at 304 revs. per minute. At this speed the fan creates a water guage of 11½ in. and delivers approximately 345,000 cu. ft. per minute. It is situated on the 33rd level at a point between the main inclined shaft and the sub-inclined shafts, which is 6,204 ft. below collar and 570 ft. below sea-level. This position is on the intake side of the mine.

The question of the position of the fan is a very important one and in this type of mine the aim should be to place the fan as far down as possible. In this case the choice of position was governed by the following considerations, which bear out the preceding statement. By placing the fan at the bottom of the main inclined shaft the delivery of the entire quantity of air entering the vertical at the surface, through the fan, to the sub-inclined shafts is assured.

In whatever position a fan is placed, a certain amount of air is bound to short-circuit from the pressure side to the inlet side without doing useful work. The control of this leakage is simplified when the fan is located in the main downcast airway, since all the doors are accessible and under constant supervision. The placing of the fan at the surface was out of the question, because of the numerous openings through which the air reaches the surface. The location of the fan above the current workings on the return side of the mine was undesirable, because of the difficulty of maintaining an airtight barrier across the mine and because of the obstruction such a barrier offers to the free flow of air through the abandoned stopes. A further advantage resulting from the position chosen is that the compressed-air released underground and the water evaporated in the workings do not pass through the fan, thereby effecting a slight saving in horse-power.

Certain disadvantages result from placing the fan in the position chosen. In the first place the fullest help from natural ventilation is not obtained, as the suction of the fan tends to decrease the density of the air in the vertical and main inclined shafts—i.e., on the intake side and the pressure of the fan tends to raise the density of the air on the return side. In the second place, the leakage which occurs in the main inclined shaft consists of hot air from the return side of the mine. Thirdly, all transport of men, rock, and material has to pass through air locks between the main inclined and sub-inclined shafts. Fourthly, the fan and motor heat the intake air to an appreciable extent. This is perhaps the greatest disadvantage attached to the present position of the fan. Although the disadvantages have been set out in full they are heavily outweighed by (1) the control which has been obtained over leakage, (2) the simplicity of splitting the air to the working places, and (3) the free passage obtained for the air from the working places to the surface.

Prevention of Leakage—(*a*) *Main Inclined Shaft.*—Between 18 station and 31 station on the main inclined shaft there are twelve stations, at each of which leakage of hot air is possible. At each station the existing door was replaced by a brick wall, in which a small door of stout timber was placed to permit persons to pass through. There were also two or three ore boxes which were filled in and walled off.

(*b*) *Transfer Levels.*—In the transfer cross-cuts on 31 and 32 levels are doors for preventing the air short-circuiting from the discharge side to the intake side of the fan. As the water gauge across these doors was found to be about 11 in., air locks were constructed consisting of three barriers on 31 level and four barriers on 32 level. Each barrier on 32 level, which is the principal transfer level, consists of three doors. The main door is hinged to the cap and is raised to the roof when necessary to allow large trailers and trolleys to pass. At the sides are small doors which are used for the passage of persons and small trucks. The small doors are hinged to a post in the usual manner and have been made air-tight by means of a thick felt seating. For greater convenience in operating these doors small panes of glass are let in to the side doors and a system of red and white lights indicates to the door boys when persons wish to pass through. Some difficulty was at first experienced with the water in the drains, as the pressure of the air was sufficient to blow this water out of the drains. The water was eventually diverted away from these levels.

(*c*) *Ore Passes.*—Reef and waste are transferred from a point below 31 level in the sub-inclined shafts to a point above 33 level in the main inclined shaft by means of two ore passes. At 32 level the reef passes out of a box on to a grizzly and then enters a second ore pass communicating with the main inclined shaft. It was, therefore, possible to place a trap-door over the grizzly. This is closed when reef is not passing through. In addition a wall was built around the tip on 32 level so that air could not pass from the sub-inclined shafts through the ore pass to the main inclined shaft on 32 level. Further, the ore passes are kept, as far as possible, full of reef or waste, which also tends to reduce leakage through them.

(*d*) *Sub-Inclined Shafts.*—At the sub-incline stations the air tends to pass out of the shafts. This is prevented by the usual ventilation doors. A little leakage at these doors is useful when tramming is in progress.

Ventilation of Engine Chambers.—On 17 level are situated the main inclined shaft hoists, together with their motors, starters, cooling water, etc. The chamber in which they are situated is ventilated by means of a volume of about 20,000 cu. ft. of air per minute, which is taken directly from the Turf vertical shaft on 16 level and blown by means of a No. 6 single inlet Sirocco fan through 30-in. piping to the top of the chamber. After passing through the chamber the air joins the main current

and passes down the mine. In this way the volume of air passing down to the main fan is not diminished, but rather augmented, since the Sirocco fan helps the main fan. The moisture-laden air from the cooling pond is short-circuited into the return air in order to reduce the heating effect on the main intake air current. It is intended to reverse the ventilation of this engine chamber at some convenient time, so as to eliminate this source of heat from the intake air.

The engine chambers on 31 level are ventilated in the reverse direction—that is to say, about 20,000 cu. ft. of air per minute is allowed to pass through the chambers and away to the returns. Special arrangements have been made to ensure that the drivers get the benefit of the fresh air.

The pump station on 32 level is ventilated by short-circuiting 15,000 cu. ft. per minute across the barrier on that level previously mentioned. At a future date this air will be diverted to the return side after having passed through the pump station.

Volumes of Air Entering the Turf Shaft, etc.—The volume of air entering the Turf shaft at the collar averages 270,000 cu. ft. per minute. Of this volume, 20,000 cu. ft. per minute is used to ventilate the engine chamber on 31 level, 70,000 ventilates the various tramming levels between 33 level and 39 level on the sub-inclined shafts (leakage through the doors on these levels is included) and about 180,000 cu. ft. per minute is concentrated on the bottom levels—namely, 39, 40, 41, and 42. When the stopes on the higher levels are worked out, it will be possible to concentrate more air on the bottom levels.

It is of interest to note that—

(1) The weight of air entering the shaft is approximately 15,500 tons per 24 hours.

(2) The air entering the shaft travels two miles as intake air and an average total distance of over five miles before again reaching the surface.

(3) The minimum volume of air per person employed underground exceeds 100 cu. ft. per minute.

(4) The water carried out of the mine by means of the return air amounts to over 1,100 gallons per hour.

Rock Temperatures.—The rise in the temperature of the rock with depth has always been a matter of great interest in connexion with deep mining. Tillard and Ranson found that the rock temperature in the Turf section increased at a rate of one degree Fahrenheit for every 219 ft. of vertical depth. Their observations were carried out at vertical depths from 5,772 to 6,869 ft. below shaft collar. Observations have been continued, by the Ventilation Officer, at each new level in depth and the results confirm those obtained by Messrs. Tillard and Ranson.

The highest rock temperature yet recorded is 100·6° F. at the 43rd level, 7,852 ft. below shaft collar, the rock cover at this point being 7,918 ft. It is expected that at 8,500 ft. below the shaft collar the rock temperature will be about 104° F.

Measures to Reduce the Heating Effect of the Rock.—While large volumes of air are of first importance in reducing the heating effect of the rock, other measures with this end in view may be summarized as follows :—

(*a*) Relaxation of Regulation 158 (10) (b).
(*b*) Maintenance of deep drains.
(*c*) Covering drains.
(*d*) Water-tight trucks.

The maintenance of water-tight trucks is important, because the drippings from same keep the floor wet and increase the evaporation of moisture.

(*e*) *Reduction of Turbulence.*—This can be accomplished by increasing the cross-sectional areas of airways where this is feasible—for example, in main shaft cross-cuts, rounding off sharp corners and removing all unnecessary obstructions. These measures are also of the highest importance to obtain the maximum volume of air from the fan through the workings. A fan running at constant speed produces a definite maximum pressure, hence more air can only be obtained by reducing the resistance of the airways. Pressure surveys with reliable aneroid or other barometers are of the greatest assistance to determine where such measures as are mentioned above are necessary.

Ventilation of Stopes.—In shafts, compression of the air is the chief heating agent and in intake levels the surrounding rock, but in stopes a new factor comes into play—namely, oxidation. No figures have as yet been published showing the effect of oxidation in heating the air. Observations made at the Turf section a few years ago show that ventilation of the stopes with drier air and reduction of any excessive use of water tends to reduce the rise in temperature in the stopes. The heating effect of oxidation is powerfully affected by increased ventilation, falling in proportion as the volume rises.

Ventilation of Stope Faces.—Air is admitted and discharged to and from the stopes at the faces and efforts are made to course the air along the faces in order to avoid useless circulation in the centre of the stopes. In special cases of particularly hot stopes, compressed air boosters are installed.

Temperatures in Stopes.—The temperatures experienced in the stopes are naturally of the greatest importance, as they tend to be higher than anywhere else in the working zone of the mine. The temperatures tend to be higher because :—

(1) The air travels the maximum distance from the surface to reach some of the stopes—i.e., those on the lateral boundaries.

(2) As a stope increases in area, the air is exposed to a large rock surface.

(3) Fresh rock is exposed at the face after every blast.

(4) The heat produced at blasting is appreciable.

(5) The comparatively large number of persons working in a stope together with their lamps giving off considerable amount of heat.

(6) The oxidation of mineral dust and of timber introduces a new and important factor in the heating of the air, which is practically absent in the intake airways.

Fortunately the effect of this formidable list of factors can be overcome by the circulation through the mine of a large volume of air. This ensures the delivery to the stope of air in which the temperature of the wet bulb is sufficiently low for work to proceed in comfort. It has long been recognized that the temperature of the air is of little importance in connexion with work at high temperatures. In other mining fields men are working in air at a temperature above that of the human body. In such conditions cooling depends on the temperature of evaporation and this is indicated by the wet bulb thermometer.

A large volume of air passing through a stope

directly reduces the effect of all the heating factors operating. It has the further advantage of increasing the cooling power of the air by increasing the rate of evaporation of sweat. Provided that an ample volume of air is available the temperature in the stope depends chiefly on its distance from the shaft and the number of working stopes the air has already traversed.

Development Ends.—The compressed air released from rock drills assisted by that blowing from a small jet on the auxiliary air pipe is sufficient to maintain cool conditions, as the following figures testify. In a development end 7,355 ft. below the collar of the Turf shaft, 7 by 6·5 ft. in section, the following temperatures were observed :—

	Dry ° *F.*	*Wet* ° *F.*
Machines running . .	89·2	84·0
Machines stopped . .	90·4	85·7

Two drifter machines were drilling, each exhausting about 140 cu. ft. of free air per minute. Compressed air was blowing from a ¼-in. jet, which, together with the exhaust from the drills, gave an average volume of 180 cu. ft. of air per minute. Three to five boys with two or three lamps were present, the walls were wet, and there was a small pool of water on the floor. The natural temperature of the rock at this depth was about 98° F.

Ventilation from the nearest through connexion is, of course, essential. This is supplied through ventilation tubing by means of small electrically-driven fans. Electrically-driven fans are used because they function when most required—that is, between shifts, when the compressed air supply has been either cut off or throttled. The air heats up as it returns along the drive, but this effect is, in the case of long connexions, counteracted by the cooling effect of air jets installed at intervals. In certain instances the ventilation of development ends is done by the exhausting rather than by the blowing-in method.

Return Airways.—The system of hanging-wall support practised permits of an area being available for the passage of the return air through the old stopes, even when the hanging and foot-wall have approached to within a foot of each other. The velocity of the air passing through the old stopes is usually very low. Therefore, the loss of pressure over the large area on a great length of the return side of the mine is almost negligible.

The importance of safeguarding return airways and the outlets for the return air can hardly be over stressed. A considerable current expenditure is being incurred on this mine in the construction and maintenance of return airways. The shafts along the northern boundary of the property are maintained in good condition for this purpose, although they have long since ceased to function as producers.

Surface rights have been obtained over the collars of three shafts of defunct outcrop properties, which are situated beyond the northern boundary, as they constitute important outlets. Access is, therefore, assured in order to maintain same in good condition. In order to provide for the possibility of serious obstruction to the return air on account of extensive settlement in the old stoped areas, special airways have been constructed in the foot-wall. The foot-wall drives and disused ore passes are utilized in the general return airway scheme. It may be mentioned that provision for return airways should be made during the early life of a mine if there is any prospect of extension to appreciable depth.

Costs.—The following list of Turf section figures gives an indication of the underground costs of a deep mine :—

Sub-inclined shafts—sinking and equipment, £20 per foot.

Development—total cost, including cleaning, etc., 65s. per foot.

Stoping, 28s. per fathom.

Shovelling and tramming, 2s. 2d. per ton milled.

Winding, 2s. per ton milled.

Pumping, 9½d. per ton milled.

Sanitation, 1d. per ton milled.

Support of workings, 20s. 6d. per fathom broken.

Ventilation, 1s. 8d. per ton milled.

Summary of Conclusions.—Certain problems become prominent in mining as great depth is attained. Some conclusions concerning these problems have been reached and are here summarized.

Handling of Men, Rock, and Material.—Rapid lowering and raising of the shift is essential and special arrangements to facilitate this should be made.

Sanitation and Health.—Special precautions are necessary to prevent infection with various diseases. To guard against heat stroke, strict supervision should be maintained over native labourers, arrangements made to see that they are fed before going on shift and a system of a probationary period of work instituted. A plentiful supply of drinking water is necessary. As conditions due to depth increase liability to accident, special attention to safety measures is essential.

Support of Workings.—The ordinary system of stope support by filled waste packs is adequate for depths down to 8,500 ft., provided that the packs are suitably spaced, strongly constructed, and maintained well up to the face.

Control of Rock Pressure.—Vertical shafts should be protected by large shaft pillars. Inclined shafts and chambers and main drives should be situated in the foot-wall and the pressure on same eased by stoping above. The size of drives and cross-cuts should be limited. Special measures are necessary for the protection of drives. Stope faces should be set back at the bottom. The mining of remnants should receive special attention.

Ventilation.—

(1) The fan should be placed so as to ensure the circulation of the maximum volume of the intake air through the workings.

(2) The greatest attention should be paid to the prevention of leakage.

(3) Large volumes of air are practically insulated from the heating effect of rock surrounding shafts.

(4) Excessive high temperatures can be avoided in shafts down to very great depths.

(5) Foot-wall drives are essential as a means of distributing the intake air free of contamination by return air.

(6) In levels the heating effect of the rock cannot be altogether avoided, but can be reduced to moderate dimensions.

(7) The heating effect of the rock from a wet surface is much greater than from a dry surface.

(8) The heating effect of the rock is affected to some extent by the degree of turbulence in the air.

(9) In stopes the heating effect of oxidation may be an important factor.

(10) Oxidation can be reduced by drier conditions.

(11) Compressed air alone will maintain cool conditions in development ends.

(12) The safeguarding and maintenance of adequate return airways is of the greatest importance.

Finally, it may safely be stated of this mine that mining will be possible to a depth of 8,500 ft. without any radical change in the present methods of either mining or ventilation and, in general, this conclusion does not exclude the possibility of mining to much greater depths if values and costs permit.

SHAFT SINKING IN ONTARIO

A description of sinking practice and costs at the Central Shaft of Macassa Mines, Ltd., Kirkland Lake, Ontario, is given by G. A. Howes in the *Canadian Mining Journal* for March. The author says that few mining companies have had an opportunity to keep costs in the same manner as Macassa for a similar depth of shaft. In this case no other mining operation was being carried on during the period by the plant. Lateral work was being done, however, from the 2,475-ft. level of the adjoining property by that company toward the Macassa shaft. This driving was timed so that it would reach to within 160 ft. of the shaft by the time the sinking operation had reached the required depth. It was then only a matter of a short cross-cut to connect the two. Hence the sinking operation absorbed all charges save a capital account of buildings, surface machinery, three underground pumps, and drills.

A total depth of 2,489 ft. was sunk. An additional 143 ft. of station cutting and 80 ft. of cross-cutting at the stations was done. The total cost per foot of sinking amounted to $70·93. The station cutting and cross-cutting costs amounted to $55·99 and $18·09 respectively.

Plant design, purchase, and erection was carried out by Mr. A. J. Keast, under whose supervision the shaft was sunk to a depth of 1,600 ft. While Mr. Keast, at this stage in the operation, was appointed manager of the Beattie Gold Mines, Ltd., he remained with the company in a consulting capacity.

From information gained in diamond drilling from surface, by a study of both the surface geology of the property and the underground geology and ore occurrences along the main Kirkland Lake fault zone farther east, it was decided to explore this break at depth. The best location, for geological reasons, was near the centre of the property.

TABLE 1

COST OF PLANT BUILDINGS

Building	*Size (feet)*	*Type of const'n*	*Cost* $
Office	20 by 20	Frame: finished inside with gyproc.	784·00
Hoist and Compressor house	50 by 30	do.	1,960·00
Dry	19 by 25	do.	787·00
Boiler house (for heating plant only)	25 by 17	2 by 4 in. and spruce lumber covered outside with good quality roofing	380·00
Blacksmith's shop	17 by 22	do.	561·00
Topman's house	11 by 11	do.	249·00
Pump house	10 by 8	do.	97·00
Substation	12 by 12	Same as office	558·00
Powder magazine	10 by 8	Same as boiler house, except with good jack pine lumber floor	455·00
Cap-house	6 by 8	Same as pump house, but with good floor	23·00
			$5,854·00

An area of about eight acres was cleared around the chosen shaft site for the erection of the necessary plant buildings, for rock dump, and for protection against fire. Materials, plant, and equipment were hauled 2 miles over an improved Government road and half a mile over a newly-constructed mine road. The total cost of constructing the mine road was $2,297·00.

No more buildings than were necessary for the job at hand were constructed. During the sinking of the first 40 ft., prior to putting in a concrete collar and erecting the headframe, building construction was being carried out. While these structures were required in connexion with shaft sinking, they also serve during subsequent underground development and hence are not strictly chargeable to shaft sinking. This also applies to the larger items of equipment costs which are listed in the next section.

Surface Plant Equipment Costs.—The figures in Table 2 cover the costs of plant equipment, including freight and haulage and the cost of installation.

TABLE 2

	$
Office equipment	636·00
Hoist and installation (except foundations)	25,548·00
Hoist foundations	1,275·00
Compressor and installation (except foundations)	7,649·00
Compressor foundations	845·00
Headframe	2,938·00
Blacksmith's shop equipment	337·00
Steel sharpener	2,462·00
Dry-house equipment	23·00
Cap-house	75·00
Substation equipment	6,528·00
Water supply system	327·00
Fire protection	49·00
Miscellaneous surface equipment	62·00
Surface track	57·00
Surface pipe-lines	773·00
Surface pumps and motors	399·00
Heating system	801·00
Boiler foundations	26·00
Total surface plant equipment	$50,810·00

Description of Plant Equipment.—The principal items of equipment consist of a modern electrically-driven hoist, a compressor, transformer and sub-station equipment, steel sharpener and other shop equipment, surface pipe-lines, pumps, small heating plant, and headframe.

The hoist is a 72 in. by 36 in. double drum, having a capacity of 15,000 lb. on a single drum, at a speed of 1,000 ft. per minute and powered by a 150-h.p. induction motor.

The compressor is a 20-12 in. by 14 in. angle compound machine delivering 1,000 ft. of free air per minute.

The headframe is a 6-post A-type timber structure 60 ft. in height and fully enclosed with painted corrugated iron sheeting. There are two head sheaves and two compartments equipped with safety doors for dumping the sinking-buckets.

Underground Equipment.—Sinking equipment consisted of the usual rock-drills hose, and accessories, sinking-buckets and crossheads, pumps, signalling system, and small tools.

TABLE 3

SHAFT SINKING COSTS PER FOOT SUNK (2,489 FT.)

	Sinking Labour and Supervision	*Drill, drill repairs, steel, air and water lines*	*Power*	*Explosives*	*Timber*	*Concrete Collar*	*Other Supplies*	*Total*
Drilling and blasting	10·378	3·564 (mat'l) 3·062 (labour)	2·899	6·367			·218	26·488
Mucking	10·884						·166	11·050
Timbering	3·546				6·087			9·633
Concreting						·215		·215
Hoisting	2·987		2·971				2·224	8·182
Decking and rock disposal	3·570						·033	3·603
Ventilation		1·519	·050					1·569
Pumping			·536				1·698	2·234
Supervision and Workmen's Compensation	4·810							4·810
Miscellaneous			·125				·509	·634
Total Direct Costs	36·175	8·145	6·581	6·367	6·087	·215	4·848	68·418
Proportion of General Charges								2·512
Total Cost per foot sunk								$70·930

SHAFT SINKING.—Sinking commenced on May 25, 1931, and the desired depth was reached on August 7, 1932. During January, 1932, an advance of 205 ft. was made, but the average per month during the operation was 172 ft. of shaft, 17 ft. of station, and 15 ft. of cross-cutting.

The shaft is 9 ft. by 17 ft. of rock excavation, timbered with 8 in. by 8 in. B.C. fir in three compartments. The man-way is 5 ft. 6 in. by 3 ft. 9 in. and the hoisting compartments 5 ft. by 5 ft. 6 in. in the clear. Sets are 7 ft. centres and bearing timbers are put in at 250 ft. intervals. The man-way is separated from the hoisting compartments by 1 in. by 7 in. sheeting.

Since the rock formation and shearings strike east and west and the long dimension of the shaft is north and south, any slabing off from the walls occurred only at the ends where narrow. This necessitated lagging the ends only. Eight-inch round spruce timber was used for this and for below and around the stations.

The man-way compartment contained the ladders, a 6-in. air line, a 4-in. water discharge line, a 1½-in. water line which supplied the machines, a 16-in. galvanized iron ventilating pipe, and the electric signal and power cables. Through this ventilating pipe the smoke was drawn to surface after each blast by a 7½-h.p. exhaust fan and within half an hour after a blast the men were able to return to work.

Sinking was carried on in three eight-hour shifts. Each shift consisted of six men, one of whom was the leader. This leader was held responsible for the work done on his shift. In addition to the sinking crew there was a hoistman and a deckman on each shift. A man helped the deckmen during the mucking periods. In addition to doing the necessary work on deck the deckman fired the boiler for heating during the winter months. A topman looked after drill maintenance, pumps, etc., and was responsible for supplies being at the shaft collar when required. The mechanical work was under the charge of this man and the responsibility of the care and condition of the cables rested with him. One blacksmith did the steel sharpening and the necessary general work. In the heavy general work which came up he was given a helper. This happened on an average of one day a week. In case of an accident, sickness, or lay-off of shaftmen four spare shaftmen were always on call so that in any event the shift was always complete. Each shaftman was given three holidays per month, his vacancy being filled by one of the spares. Each of the three shifts was capable of carrying on either drilling, mucking, or timbering, so that the operation was kept continuous.

(1) *Drilling.*—Four drills per drilling shift were used with one spare taken down in case of trouble. These were 3½-in. water leyner type drifters equipped with plugger handles. These machines were carefully inspected after each drilling and repaired if necessary.

TABLE 4

COSTS IN UNITS OF LABOUR, POWER, AND SUPPLIES

		Man hours per foot
Labour—		
Drilling, blasting, and blowing smoke		8·52
Mucking		11·53
Timbering		2·61
Baling water		0·65
Miscellaneous and delays		0·93
Total Shaft Crew		24·24
Feet per 8 hour man shift—shaft crew only—0·33.		
Surface Crew—		
Hoistmen		4·44
Dumping and disposal of rock		7·90
Blacksmithing, steel sharpening, drill repairs, and general surface		3·28
Supervision and clerical		2·80
Total man hours per foot surface		18·42
Feet per man shift, surface		0·433
Total crew-shaft and surface—		
Man hours per foot		42·66
Feet per 8 hour man shift		0·187
		Per foot of shaft
Materials and supplies—		
Explosives :		
40%	pounds	19·0
50%	,,	7·7
60%	,,	2·5
Total all strengths	,,	29·2
Timber :		
Shaft sets (8 in. by 8 in. timber)	B.M.	85·0
Blocking (8 in. by 8 in.)	,,	17·2
Sheathing (1 in. by 7 in.)	,,	5·0
Guides	,,	12·5
Total	,,	119·7
Round lagging (8 in. poles) Linear feet		18·0
Drill Steel	pounds	2·0

TABLE 5

PERFORMANCE DATA

Days worked in shaft		4·23
Progress per day of 24 hours	feet	5·90
Progress per round		5·03
Number of rounds completed		4·95
Drilling—		
Number of holes per round		38
Number of steels sharpened per round		195
Total drilling per round	feet	300
Drilling per foot of advance	,,	59·64
Average number of buckets hoisted per round		67·7
Average number of buckets hoisted per foot of advance		13·45

The type of cut found most satisfactory was the double V. An average of 38 holes was drilled per round, 16 in the cut and 22 in the square. The average drilling time, including setting up, taking down steel, and loading the cut holes, was 4½ hours.

One-inch quarter-octagon steel was used. One round required 195 pieces of steel on the average; the gauges varying from 1⅞ in. for starters to 1⅝ in. for fifths.

Air and water were supplied to the drills through a header or manifold. When work other than drilling was being done this was left at the station nearest the bottom and, at the beginning of a drilling period, was suspended on one of the cables at the required height from the bottom. The other compartment was then free for baling water. Line oil lubricators were placed between the header and the air hoses for drill lubrication.

(2) *Blasting.*—50% gelatine dynamite was used in blasting the cut and 40% in the square. The cut holes were blasted and mucked clean before the square-up holes were leaded. An average of half an hour was taken in loading and blasting each.

Delay action all-metal detonators were used. These ranged from 0 to 10 and were fired from an electric 110-volt switch at the surface.

A two-ton blasting set was kept chained to the bottom of the last set of timber and was lowered by means of two 1½-ton chain blocks in timbering periods.

(3) *Mucking.*—To a depth of 1,800 ft. three 2,200 lb.-capacity sinking-buckets were used. From that depth to the bottom these were replaced by three 3,000-lb. buckets, the difference in size making up for lost time in hoisting this distance. Mucking the cut took from 3 to 3½ hours on the average and the square-up from 7 to 8 hours. One bucket of water was hoisted to every 5 of muck. The cut averaged 26 tons and the square 72 tons.

(4) *Handling Water.*—Apart from the water from the drills no flows were encountered below the 500-ft. horizon. The water came in from fractures all the way from surface to this level. A 50-g.p.m. pump, driven by a 10-h.p. motor, was installed in the 500-ft. station where a dam was built. Water rings were put around the shaft above the station with pipes leading from them to the dam. In spite of the rings some water kept going below. At the 1,000-ft. level station another dam was put in and a 110-g.p.m. pump powered by a 20-h.p. motor installed with two more rings just above the station. Both these pumps discharged direct to surface. This procedure solved the water problem as far as was necessary. Baling took care of the rest until sinking was completed when more pumps were added below.

Most of the fractures where the flows were encountered down to the 500-ft. horizon were cemented off by means of a heavy pump, the cement being forced in under pressure after holes had been drilled into them.

Cost of Sinking.—Table 3 shows the itemized sinking costs for the shaft in which the total cost is distributed over the several operations involved. Development costs whether for sinking, driving, cross-cutting, or rising are usually higher during a purely development programme than similar costs at a producing property, since in the former instance the development work must absorb all pumping, surface costs, and overhead charges, in the latter instance borne in large measure by ore production.

The shaftmen paid for their own shovels over a consumption of twelve per month and for all explosives over $5·60 per foot. They earned an average of about $8·50 per shift.

POSTMASBURG MANGANESE DEPOSITS

In the MAGAZINE for May, 1927, extracts were given from a report by Dr. A. L. Hall on the important deposits of manganese discovered by Capt. T. L. Shone in 1922 close to Postmasburg in the Cape Province, a map of the deposit being also reproduced. Further work by Dr. L. T. Nel was summarized in the issue for June, 1929. A new account of these deposits has now been written by Dr. A. L. du Toit and appears in *Economic Geology* for March–April. Extracts from this article are given here, the author being particularly interested in the origin of the manganese as he does not agree with the syngenetic theory advanced by Schneiderhöhn in his description of the deposits published in 1931. The first sections of the paper deal with the geological structure of the area, the features indicating replacement as the mode of origin, and the process of replacement envisaged by the author. Going on to the ores themselves the author says that, as pointed out by Hall and Nel, two main types of ore are present: (*a*), a grey to black amorphous or cryptocrystalline kind with occasional banded, botryoidal, or drusy structure, and with a specific gravity as low as 4·3; and (*b*), a glittering steel-grey to blackish, finely to coarsely crystalline kind in which pyramidal to pseudo-cubic faces may be recognized, the specific gravity ranging from 4·8 to 5·0. In (*a*) psilomelane predominates, while much of (*b*) agrees well with braunite, though Schneiderhöhn has shown that the Indian mineral sitaparite is also represented, building the larger crystals. The ore mined is a mixture of (*a*) and (*b*), commonly an intimate one, with the relative proportions varying greatly even in different parts of a hand specimen, though in particular quarries one kind may predominate.

As the paragenetic scheme deduced by Schneiderhöhn includes not only metamorphic, but pre-metamorphic manganese minerals, some slight modification thereof is demanded when an epigenetic origin is postulated. With such amendment the ore-mineral transformation would normally be:—manganese gel → "psilomelane" → pyrolusite and polianite → braunite → sitaparite—which is suggestively in the order of increasing density. The derivation of sitaparite from braunite would need the removal of SiO_2 and the addition of Fe_2O_3, and Schneiderhöhn has shown that the latter has been furnished by tiny inclusions of hematite in the braunite. Like the minute flakes of mica they are set roughly parallel to the bedding of the parent shale and are regarded by him as marking layers primarily richer in iron, but by the author as laminæ selectively impregnated by ferric hydrosol, which is in process either of expulsion or of absorption into the new-forming manganese mineral.

The transformation would require the elimination from the braunite of most of its silica. The clayey matter, on the other hand, became recrystallized into diaspore (mainly) and soda-margarite (rarely). It is clear that, in the progressive enrichment of the ferruginous manganese ores or in the manganization of the Blinkklip breccia or Gamagara conglomerate with their hematitic inclusions, most of the ferric oxide so set free must have been passed up to higher levels to give rise therein to hematitic impregnation and ores.

Under metamorphism the structure of the ore has changed progressively from amorphous to coarsely crystalline, though even in the latter all traces of the bedding of the replaced rock, where such was shale or conglomerate, have not always been obliterated. In the braunite-rich varieties that mineral is commonly xenoblastic to idioblastic, but the most highly-altered types carry porphyroblasts of sitaparite and diaspore—significantly both small-volume minerals. Although Schneiderhöhn holds that there are no signs microscopically of internal stress-movement it should be emphasized that the triple or quadruple recrystallization of the manganese compounds deduced by the microscope could be anticipated to have masked any such action, since it is in a sense analogous to the annealing process in metallurgy.

The above mineralogenetic picture is doubtless more simple than the truth. Each paramorphism must have brought about its corresponding shrinkage in volume and, owing to repeated fracturing of the ore-zone by sub-surface solution, fresh colloidal compounds of Mn and Fe together with SiO_2 and Ba must have been introduced intermittently. The recorded presence of younger growths of psilomelane, pyrolusite, and wad, more especially within cavities, thereby finds a ready explanation.

Hall and Nel have pointed out that the low proportion of sulphur present (about 0·05%) is wholly insufficient to fix the barium, indicating that most of that element is in chemical combination in the manganese minerals; this also seems to be the case with some of the silica and the small amount of potassium that is present.

A characteristic and valuable property of the ores is their extremely hard, massive, and more or less crystalline structure, the material being in the main harder than steel. The cavities form a fraction of the total bulk and are either empty or partially or completely filled with wad or barite, more rarely with opal. An incipient greenish sheen accompanied by mottlings of wad signals a lower grade, as does also a fissile structure in the finer-grained types that have commonly arisen from shales. Where relics of conglomeratic or brecciaform structures are detectable the proportion of iron is almost invariably high. Where the parent rock has been chert irregular blebs or patches of cherty silica or of recrystallized quartz are dotted unevenly through the massive ore, tending to give the material a curious brecciaform appearance (sausage-ore).

The content of metallic manganese in places exceeds 54 per cent, but commonly is less. Analyses of the various types have been published by Hall and Nel, which show that they are particularly low in S and P. Since these analyses have been based on small samples the following bulk analyses of overseas shipments made by the Manganese Corporation during 1930–31 will be of value :—

% Mn	Mn	Fe	SiO_2	Al_2O_3	BaO	P
Over 52 .	52·41	7·15	6·22	1·36	1·54	0·061
50 to 52 .	50·93	7·65	6·02	1·61	1·78	0·073
47 to 49 .	48·12	11·24	5·79	2·35	1·83	0·079
42 to 45 .	43·87	14·91	5·59	2·21	2·48	0·088

The regular rise in the proportion of impurities with fall in the manganese content, save in the case of the silica, is noteworthy.

The writer has suggested that the tectonic history of the area may be compared with that of the Swiss Jura, where upper competent beds, resting upon and moving over a shaly sole, were folded with but limited buckling of the massive strata beneath. At Postmasburg the varied strata from the ore-zone upwards have been tilted and folded over large areas, whereas the supporting dolomite alongside shows only limited undulations. The "sole" in this case was constituted by the upper contact of the dolomite which suffered solution, so that the overlying beds, in adjusting themselves to the folding and solution of the basement, suffered considerable tilting and fracturing.

Puckering, together with thickening of the ore-body, occurs along anticlinal axes, just as in "saddle reefs," and in one case erosion has laid bare the corresponding swelling along the trough. Nevertheless, despite such folding, the zone—hematitic above, manganiferous below—displays a remarkable regularity though, as stated earlier, it tends to alter appreciably its boundaries and stratigraphical "horizon" along and across the strike. These, and other observations, suggest that the metasomatism was effected mainly during the earlier phase of crustal movement, the subsequent stages thereof bringing about the deformation of the strata and of the soft mineral replacements, the dehydration of the latter, and the crystallizing of new minerals therein. It can also be surmised that the circulation of waters in the dolomitic basement and hence the positions of the principal solution-belts were both influenced, if not governed, by the progressing deformation of the zone of replacement.

Metasomatism probably ceased with the termination of the folding and the subsequent erosion of the region in pre-Carboniferous times, but it is likely that minor additions and rearrangements of the Mn, Fe, and Si continued and may even be in progress to-day. It is instructive to note that in the dolomite territory loose pebbles and even the hard surface soil become coated in a few years' time with a dense patina of psilomelane through the evaporation of soil-water bringing up traces of manganese salts. As yet no clear evidence has been obtained to support appreciable secondary surface enrichment, though in a number of places important accumulations of high-grade detrital manganese ores have been formed by the direct solution of the uppermost part of the dolomite and the release of its sporadic seams of primary ore. Schneiderhöhn has detailed the secondary development of polianite, pyrolusite, psilomelane, quartz, and chalcedony, but it would seem more likely that some of these transformations really mark the final stages in the main mineralization and are not truly recent phenomena.

No close comparison can be made with any of the well-known deposits of the world which, in view of the unique set of circumstances attending the emplacement of the South African bodies, is

hardly a matter for surprise. The writer has, however, drawn attention to a parallel with the Burnier and Rodeio deposits of Minas Geraes, Brazil.

There can be no doubt that an intensive study of the Postmasburg fields, as they are opened up, will yield much information of great mineralogenetic importance. In the meantime it is freely admitted that the present contribution only touches the fringe of the various problems involved in these remarkable occurrences.

MINING.—In the Eastern Belt development has so far been confined to the several outliers between Doorn Put and Klipfontein, where the ores are practically restricted to the chert zone, the dip of which is commonly low. The deposits do not form a single bed, but a discontinuous series of partial or complete replacements of various horizons, a matter for surprise being the quantity of ore so frequently disclosed upon opening up what would casually seem almost barren ground. Despite the unpromising nature of much of the outcrop good tonnages can be anticipated from this section and not improbably from some of the other outliers farther to the north. In places a high Mn content is found, 59-60%, and the ores are low in Fe and Al but, as would be expected from their parentage, high in SiO_2, though S and P are both insignificant.

There are large amounts of hematite in the cappings of Blinkklip breccia, more particularly on the Klipfontein Hills. These, which were described by Wagner, are of Bessemer grade with 65–69% Fe; 0·1–0·15% P_2O_5; and 0·2–0·3% S, the latter due to traces of pyrite.

In the Western Belt development has been active over the nine-mile stretch between Beeshoek and Paling, where the beds replaced are chiefly Matsap, the workings having purposely been strung out so as to section the mineralized zone. Although a regular and persistent feature the latter shows considerable variation in the degree of its mineralization from point to point, but appears to be mineable over the greater proportion of the outcrop within this section. It is surprising how much ore is present even in working faces that do not look promising. The ratio of ore to waste over most of this stretch can be taken as lying between 1 : 6 and 1 : 3.

Normally the ore grades upwards into hematitic types and the purity of the material can be determined to within close limits by the tint of the smoke produced during blasting; with increase of the iron content, the colour changes progressively from black through chocolate to red. The percentage of iron is commonly higher than that of silica. Alumina is remarkably low, 1·3–2·3%, which proves the thorough replacement and elimination of the dominantly argillaceous material and furthermore shows that these ores are not mere lateritic muds, statically metamorphosed.

The extent of outcrop being so great, mining under cover will be unnecessary, exploitation resolving itself into quarrying with separation from the waste and the iron-rich varieties; the latter, though at present discarded, may in the future be used for making ferro-manganese. The zone is moreover accessible; dips at low to moderate angles westwards, save in the folded and hilly central section; and the water-table is deep. The ore is excessively hard and averages 8 cu. ft. to the short ton when solid and about 13 when broken. At the central depot at Mancorp the ore is classified into four grades, crushed to lumps not exceeding six inches across, and railed to the 50,000-ton loading-plant at Congella, Durban, 743 miles distant. Freight charges account for the greater part of the costs of production.

Although development has shown the uncertainties involved in making close estimates on these fields, there can be no doubt as to the huge tonnages available even down to shallow depths and, without considering the extensive area to the north of Paling or the Eastern Belt, the total reserves must furthermore be enormous! The output has hitherto been exported mainly to America and Japan, but negotiations are proceeding towards the establishment of a ferro-manganese industry on a large scale in Canada. The hardness and relative purity of the ore have commended it to consumers and, with the return of the world to less abnormal conditions, important developments can be anticipated on the Postmasburg manganese fields.

MICROSCOPIC ANALYSIS WITH AN INTEGRATING STAGE

In *Economic Geology* for March–April F. E. Thackwell describes the application of quantitative microscopic methods with an integrating stage to geological and metallurgical problems. The author says that the main purpose of his article is to direct attention to a new development in the field of microscopic analysis, which should prove of importance to progress in the scientific solution of geological, mineralogical, and metallurgical problems that are dependent upon microscopic data. This new development is in the form of an integrating stage.[1] It is simply a mechanical application of the Rosiwal principle of geometric (or planimetric) analysis, which has long been known to the science of geology. Although the device was designed primarily for rock analysis, with the petrographic microscope, it is equally suitable and has a wider application in the field of ore-dressing. An important application of the microscope is being developed in this field for the statistical microscopic analysis of ores and mill products. The Co-operative Microscopic Laboratory of the Utah Engineering Experiment Station, University of Utah, is one of the pioneers in this work and the example of the use of the integrating stage herein cited is from one phase of this type of analysis.

This type of microscopic analytical work requires counting by area estimation (or by diameters) of as many as 400,000 mineral grains for a single study. Furthermore, present day ore concentration requirements are such that an average of between 50 and 90% of these mineral grains treated are of diameters less than the opening of a standard 200-mesh sieve (0·074 mm. or 0·0029 in.). In general, samples representing the ore in any particular investigation are prepared for counting by the usual method employed for polished section

[1] Manufactured by E. Leitz, of Wetzlar, Germany.

study; the relative areas of the various minerals are determined by direct area estimation, by grain count, or by summation of diameters, in any case using a travelling stage and a net ruled eyepiece; the percentage volumes are subsequently calculated; and finally, the percentage weights are computed from the specific gravities of each mineral. Finely-ground mill products are sized by sedimentation and the fractions incorporated in bakelite briquets, which are polished for the microscopic count as in the case of hand specimens. Accurate and detailed statistical counts are made by this procedure on material down to minus 2300-mesh in size (approximately 0·006 mm. or 0·00023 in. particle diameter). The counting of these thousands of minute particles is a lengthy, wearisome task and involves a great deal of eye strain. The recording and totalling of the counts is in itself a tedious operation. Although the various institutions engaged in this work have made numerous improvements in technique to lessen the time and strain of microscopic counting, the nature of this phase has remained a serious handicap.

S. J. Shand, as early as 1916, developed a mechanical recording micrometer (employing the Rosiwal principle) for reducing time and eye strain in counting. This stage attachment by Shand was the basis for the design of the integrating stage with which this present article is concerned. That latter attachment, developed by E. Leitz, Wetzlar (Germany), is called a "planimetric" or "integrating" stage. Although primarily intended for use on a polarizing microscope the instrument is equally adaptable to reflecting microscopes. This apparatus has six or four independent measuring spindles, with the aid of which the proportional amounts of six or four different constituents may be summed in one operation and a surface of 18 by 18 mm. planimetrically evaluated. An area of 18 by 18 mm. on an average briquet of minus 400- plus 560-mesh mineral particles, for example, contains between 5,000 and 6,000 individual particles. The exactness of the readings furnished by the micrometer spindles is such that within an integrating distance of 25 mm. along each component the error does not exceed 0·01 mm. The release of all the spindles causes the integrating stage to return automatically to its initial position along the measuring line, whence it may be set accurately within 0·1 mm. to another line with the aid of a rack and pinion motion.

To compare the use of the integrating stage with counting as previously done, a briqueted mill product was chosen which contained only a limited number of common minerals, in appreciable quantity, so that chemical analyses were available for recombining the elements into the correct mineral composition. Thus chemical results could be used as a yard stick for comparison of the accuracy of the two counting methods. Ordinarily the complexity of the minerals in ores and concentrator products is such that the elements determined chemically cannot be recombined to give the correct mineral composition until the quantitative ratios of the minerals are determined by the microscopic count. The conditions and results of the comparison count may be summarized as follows:—

Sample: Mill tailing from a concentrator treating a complex lead-zinc ore by differential flotation. *Particle size:* Minus 100 plus 150 mesh (average particle diameter 0·125 mm.). *Illumination:* Artificial light from a day-light bulb was employed as reflected light using a vertical illuminator. *Comparison of areas counted:* In each case, 12 equidistant, parallel strips across the surface. *Timing of counts:* Total time of actual counting plus time for recording figures during the progress of the count.

Minerals Counted	*Results of count by area estimation using net ruled eyepiece*		*Results of count using Leitz Integrating Stage*		*Chemical Results*
	Number of unit areas counted	Per cent by wt. rep. by each mineral	Micrometer spindle readings (diameters)	Per cent by wt. rep. by each mineral	Per cent by wt. calculated from chemical analysis
Pyrite	4068	16·74	4380	16·46	16·09
Galena	78	·48	97	·55	·58
Sphalerite	558	1·84	680	2·05	2·39
Totals	4734	19·06	5157	19·06	19·06
	Gangue	79·94		79·94	79·94
	Total	100·00		100·00	100·00
	Time of count = 1 hr. 35 min.		Time of count = 50 min.		

Note.—The figures in the columns above giving the percentages by weight represented by each mineral were calculated from the counts by the usual method involving multiplying by the specific gravities of each respective mineral to convert areas to weight relationships and finally into mineral composition of the sample.

SUMMARY.—In a survey of the literature in the fields of geology, mineralogy, and metallurgy it is apparent that the value of quantitative microscopic analysis has, in part, been long realized. It is also apparent that there has been marked inhibition to the use of this phase of microscopic investigation because of the tedious character of its methods of application. The new integrating stage materially reduces past objections, since it decreases counting time by approximately one half, greatly reduces eye strain and recording inconveniences, and insures a high degree of accuracy.

Although this comparison test of counting methods was confined to a single instance on a specific type of work it furnishes a reliable basis for demonstrating the advantages of the integrating stage method in its general application to quantitative microscopic work. Geological or metallurgical problems (other than the ore-dressing type used for this demonstration) involve the same principle, and therefore the time factor, accuracy, and other advantages indicated in this case are undoubtedly equally applicable. All the conditions encountered in the technique of planimetric microscopic counting in a complete analysis, or a more complex problem, were involved. This new mechnical stage development should aid in adding impetus to the general use of quantitative microscopic analytical studies and it is believed timely to offer these observations for the purpose of directing the attention of researches in geological and metallurgical sciences to the subject.

SHORT NOTICES

Cut-and-Fill Stoping.—In Information Circular 6688 of the United States Bureau of Mines C. H. Johnson and E. D. Gardner discuss the application of cut-and-fill methods of stoping.

Mining under Caved Areas.—A method of mining pillars surrounded by caved waste and stope bottoms covered by waste is described by F. S. McNicholas in the *Engineering and Mining Journal* for March.

Shrinkage Stoping.—C. H. Brehm discusses shrinkage stoping (Schrumpfbau) in *Metall und Erz* for March 1.

Mine Transport.—Morris J. Elsing summarizes the costs of mine transport in the *Engineering and Mining Journal* for March.

Rock-Drills.—The second part of an article on rock-drills and their accessories by L. Eaton appears in the *Engineering and Mining Journal* for March.

Compressed Air.—The first part of a paper by R. James on the production and use of compressed air, read before the South Wales and Monmouthshire branch of the National Association of Colliery Managers at Cardiff, appeared in the *Iron and Coal Trades Review* for March 3.

Explosives.—A paper on mining explosives, with notes on low-density dynamites, by W. J. Davies, appears in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for January.

Liquid Oxygen Explosives.—Some further notes on the use of liquid oxygen explosives by T. Coulter and A. E. Lance are given in the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for January.

Valuation of Ore Deposits.—Bulletin 356 of the United States Bureau of Mines by C. F. Jackson and J. B. Knaebel deals with the sampling and estimation of ore deposits.

Diesel Locomotives in Mines.—J. Boulinier discusses the use of Diesel locomotives in mines in the *Revue de l'Industrie Minérale* for March 1.

Levelling.—An article by W. T. Lane in the *Colliery Guardian* for March 10 deals with the use of the modern level.

Placer Concentration.—A plant for the centrifugal concentration of placer material erected in Arizona is described by J. B. Girand in the *Engineering and Mining Journal* for March.

Explosive Crushing.—A second report on the explosives shattering of minerals by R. S. Dean and John Gross is given in Report of Investigations 3201 of the United States Bureau of Mines.

Diamond-Drill Bits.—W. Rex Storms discusses correct settings for drill bits and the choice of carbons in the *Engineering and Mining Journal* for March.

Pulverized Coal.—A paper by H. D. Tollemache on the use of pulverized coal as fuel was read before the South Wales Institute of Engineers on March 23.

Mount Isa.—The geology of the Black Rock lode at Mount Isa is described by S. R. L. Shepherd in the *Queensland Government Mining Journal* for December 15 last.

The Homestake Mine, South Dakota.—Metamorphism and hydrothermal alterations in the Homestake gold-bearing formation, South Dakota, are discussed by J. K. Gustafson in *Economic Geology* for March–April.

Canada's Pre-Cambrian.—A paper on the gold belts of the Canadian Pre-Cambrian appears in the *Canadian Mining Journal* for March.

Gold and World Trade.—J. R. Finlay discusses the relation between gold and world trade in *Mining and Metallurgy* for March.

Asphaltites in Oil-Shale.—The occurrences, nature, and origin of asphaltites in limestone and oil-shale deposits in Estonia are described by P. N. Kogerman in the *Journal* of the Institution of Petroleum Technologists for March.

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.*

20,469 of 1931 (386,969). MANCHESTER OXIDE CO., R. H. CLAYTON, H. E. WILLIAMS, and H. B. AVERY, Manchester. Impure sulphur is washed with a saturated solution of sulphur in carbon bisulphide to remove tarry impurities, the sulphur itself being subsequently treated by carbon bisulphide in the same vessel to extract the sulphur.

22,786 of 1931 (387,713). T. J. TAPLIN and MINERALS SEPARATION, LTD., London. Chlorination process for the heat treatment of non-ferrous ores in which the heated mixture at reaction temperature is discharged into a soaking pit, to remain until the reaction is completed.

23,197 of 1931 (387,019). MANCHESTER OXIDE CO., R. H. CLAYTON, and F. W. SKIRROW, Manchester. Solutions of impure sulphur in carbon bisulphide are treated with fuming sulphuric acid to get rid of tarry impurities.

28,113 of 1931 (386,730). INTERNATIONAL COMBUSTION, LTD., London. Improvements in planetary ball-mills in which the inner grinding ring is driven through springs to avoid breakage when treating tough material.

64 of 1932 (387,100). A. C. DAMAN, Denver, Colorado. Flotation apparatus is constructed to incorporate an impeller arranged to rotate on a vertical axis below a stationary hood having connexions for the supply of pulp to the impeller.

921 of 1932 (386,790). VEREINIGTE STAHLWERKE A.-G., Dusseldorf, Germany. Ferric chloride is electrolyzed in the liquid phase for the production of electrolytic iron.

11,658 of 1932 (387,181). NEW JERSEY ZINC CO., New York. Ores containing zinc sulphide are treated with sulphuric acid to produce a solution of zinc sulphate and H_2S, the gas being used later to precipitate pure zinc sulphide from the clarified solution.

11,676 of 1932 (387,548). W. P. WILLIAMS, London. Ores carrying gold and silver in the presence of "cyanicides" are first oxidized by an air treatment and then treated by alkaline earth compounds to remove the oxidized cyanicide before attempting to recover the precious metals.

20,742 of 1932 (386,896). T. LEWIN, St. Louis, U.S.A. Process for the electrolytic deposition of copper from anodes of secondary metals in which the cell-slime is oxidized and used as an agent for the precipitation of the anodic impurities colloidally suspended in the electrolyte.

24,152 of 1932 (387,265). VEREINIGTE STAHLWERKE A.-G., Dusseldorf, Germany. Ferruginous ores or iron scrap are used as the anode during the electrolysis of molten ferric chloride.

26,295, 26,296, and 26,297 of 1932 (387,724–5–6). H. OSBURG, New York. Lithium alloys or salts are used as scavengers or improvers in the treatment of molten metals and alloys.

27,090 of 1932 (387,629). VEREINIGTE STAHLWERKE A.-G., Dusseldorf, Germany. Molten ferric chloride is treated with hydrogen for the recovery of pure iron.

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.

Elements of Mining. By R. S. Lewis. Cloth, octavo, 510 pages, illustrated. Price 31s. London: Chapman and Hall; New York: John Wiley and Sons.

Earth-Lore: Geology without Jargon. By S. J. Shand. Cloth, octavo, 134 pages, illustrated. Price 5s. London: Thomas Murby and Co.

Treatise on Sedimentation. 2nd edition. By W. H. Twenhofel. Cloth, octavo, xxv + 926 pages, illustrated. Price 46s. London: Baillière, Tindall and Cox.

Mining and Geological Map of Southern Equatorial Africa. Scale 1 : 5,000,000. Price 12s. London: Thomas Murby and Co.

Special Steels. Chiefly founded on the researches regarding alloy steels of Sir Robert Hadfield. 2nd edition. By T. H. Burnham. Cloth, octavo, 233 pages, illustrated. Price 12s. 6d. London: Sir Isaac Pitman and Sons.

Anhydrite in Canada: Occurrence, Properties, and Utilization. By L. Heber Cole and R. A. Rogers. Paper covers, 89 pages, illustrated. Price 20 cents. Ottawa: Department of Mines.

Canada: Preliminary Report on Mineral Production, 1932. Paper covers, 39 pages. Ottawa: Dominion Bureau of Statistics.

The Volcanic Area of Bufumbira, South-West Uganda. Geological Survey of Uganda Memoir No. III. Part I, Geology, with Notes on the Petrology and Economic Geology. By A. D. Combe and W. C. Simmons. Paper boards, 150 pages, illustrated, with maps. Price 15s. Entebbe: Geological Survey Office.

Mineral Resources of the United States, 1931. Part I, pp. 265–296, Zinc, by E. W. Pehrson, pp. 317–330, Secondary Metals, by J. P. Dunlop. Paper covers, each part 5 cents. Washington: Superintendent of Documents.

Quin's Metal Handbook and Statistics, 1933. Pocket size, 281 pages. Price 5s. London: Metal Information Bureau, Ltd.

Stock Exchange Official Intelligence, 1933. Cloth, 2021 pages. Price 60s. London: Spottiswoode, Ballantyne and Co.

COMPANY REPORTS

Robinson Deep.—Formed in 1915, this company works a deep-level gold-mining property on the Central Rand. The report for 1932 shows that 1,401,926 tons of ore was mined, the tonnage milled, after sorting out waste, being 1,168,500. The gold yield totalled 337,699 oz., worth £1,452,457, sundry items bringing the total revenue up to £1,460,966. Working costs amounted to £1,127,772 and the working profit to £333,194. Dividends declared during the year absorbed £177,923, equal to 3s. on the "A" shares and 1s. 1½d. on the "B" shares. The ore reserves at the end of the year were estimated to be 3,076,000 tons, averaging 5·8 dwt. in value over a stoping width of 59 in., as compared with 2,592,000 tons, averaging 5·9 dwt. over 60 in., at the end of the previous year. As a result of the Union Government having abandoned the gold standard, however, additional tonnages of low-grade ore, averaging less than 4·5 dwt. in value, will immediately become available. The programme of work at deep levels at this mine is being pursued with highly satisfactory results and it is confidently anticipated that the operations projected down to a depth of 8,500 ft. will be achieved without great difficulty and without calling for any abnormal expenditure of capital.

Simmer and Jack Mines.—This company was formed in 1924 and operates a gold-mining property on the East Central Rand. The report for the year 1932 shows that 1,201,618 tons of ore was mined and, after sorting out waste, 944,000 tons milled. The gold recovered totalled 260,081 oz., worth £1,119,248, realization expenses being £2,493 and sundry revenue, £13,881. Working expenditure totalled £982,687 and the working profit £147,949. A dividend equal to 5% was paid during the year, absorbing £31,250. The ore reserves at the end of the year were estimated to amount to 1,645,300 tons, averaging 6·0 dwt. over a stoping width of 50 in., as compared with 1,558,700 tons, of the same value and width, at the end of the previous year. Some ore of a grade below 4·0 dwt.—the present pay limit—will become immediately available for working in consequence of the departure of the Union from the gold standard. The acquisition of 525 claims from the Government, during the year under review, considerably extends the company's claim area.

East Rand Proprietary.—This company was formed in 1893 and works an amalgamated group of properties on the East Rand. The report for 1932 shows that 2,155,500 tons of ore was mined and, after sorting out waste, 1,907,000 tons was milled, yeilding 502,347 oz. of gold, worth £2,130,566. Silver and osmiridium recovered brought the total revenue up to £2,135,096. Working costs were estimated at £1,990,743 and the working profit at £144,353. Two dividends were paid during the year, each of 2½%, and they absorbed £75,000. The available ore reserves at the end of the year under review were estimated to be 3,655,240 tons, averaging 6·2 dwt. in value, as compared with 3,519,480 tons, averaging 6·3 dwt., at the end of the previous year. These reserves will, of course, be considerably augmented by low-grade ore which will be brought in above the new pay limit.

Modderfontein B.—Formed in 1908, this company works a gold-mining property on the Far East Rand. The report for 1932 shows that 1,040,885 tons of ore was mined and sent to the mill, where, after sorting out waste, 912,000 tons was crushed. The gold recovered totalled 255,685 oz., worth £1,084,109, while the silver, osmiridium, and diamonds recovered brought the total revenue up to £1,089,135. Working costs were £716,808 and the working profit £372,527, of which £350,000 was distributed as dividends, equal to 50%. The available ore reserves at the end of the year were estimated to be 961,750 tons, averaging 6·6 dwt. in value over a stoping width of 51·2 in., as compared with 1,034,710 tons, averaging 6·5 dwt. over 49·3 in., at the end of the previous year. A large tonnage of ore, heretofore considered unprofitable, will be brought into the reserves consequent upon the departure of the Union from the gold standard.

Durban Roodepoort Deep.—This company was formed in 1895 and works a gold-mining property on the West Rand. The report for the year 1932 shows that 672,752 tons of ore was mined

and sent to the mill, where, after sorting out waste, 593,900 tons was crushed, yielding 188,672 oz. of gold, worth £800,147. Silver and osmiridium recovered brought the total revenue up to £801,706, while working costs were estimated to be £701,896, leaving a working profit of £99,810. Dividends paid during the year absorbed £56,250, equal to 15%. The available ore reserves at the end of the year were estimated to be 2,268,100 tons, averaging 6·34 dwt. in value over a width of 51·3 in., as compared with 2,150,200 tons, averaging 6·7 dwt., at the end of the previous year, these figures, of course, being based on the pay limit existing before the Union left the gold standard.

City Deep.—This company was formed in 1899 and works a deep-level gold-mining property on the Central Rand. The report for 1932 shows that 1,064,568 tons of ore was mined and sent to the mill, where, after sorting out waste, 986,500 tons was milled, yielding 257,110 oz. of gold, worth £1,089,840, the silver and osmiridium recovered bringing the total revenue up to £1,091,745. Working expenses totalled £1,020,468 and the working profit £71,277, as compared with a loss of £1,626 in the previous year and of £23,040 in 1930. The available ore reserves at the end of the year were estimated to be 1,694,800 tons, averaging 6·1 dwt. in value over a stope width of 43·4 in., as compared with 1,323,800 tons, of the same value, at the end of the previous year. The improved outlook for this company, in view of the increased price now obtained for gold, warrants acceleration of development to such a point that milling on a full scale may be resumed and a programme having this end in view is under consideration.

Rose Deep.—This company was formed in 1894 and works a deep-level property on the East Rand. The report for 1932 shows that 795,800 tons of ore was mined and that, after sorting out waste, 748,850 tons was crushed, yielding 154,640 oz. of gold, worth £655,603, silver and osmiridium recovered bringing the total revenue up to £657,015. Working costs amounted to £624,575 and the working profit to £32,440. The available ore reserves at the end of the year were estimated to be 748,700 tons, averaging 4·5 dwt. over a stoping width of 59 in., as compared with 762,700 tons of the same grade at the end of the previous year. The reserves will, of course, be substantially increased now that the price of gold has risen. Serious caving in the mine has given considerable trouble, but provided no further bursts are experienced it is expected to maintain the same rate of mining during the current year.

Government Areas.—Formed in 1910, this company works a deep-level property on the Far East Rand. The report for 1932 shows that 2,491,000 tons of ore was treated, yielding 1,146,140 oz. of gold, the total revenue amounting to £4,868,493. Working costs were £2,176,324 and the working profit £2,692,169, equal to 21s. 7·3d. per ton milled. Dividends paid during the year absorbed £1,260,000, equal to 90%, the Union Government's share in the profits amounting to £1,473,777. The ore reserves at the end of the year were estimated to contain 9,860,000 tons, averaging 8·9 dwt. over 60 in., figures based, of course, on the standard price of gold.

Randfontein Estates.—This company, formed in 1889, works a gold-mining property on the Far West Rand. The report for 1932 shows that 3,102,754 tons of ore was mined and that, after sorting out waste, 2,925,000 tons was crushed, yielding 821,334 oz. of gold. The total revenue amounted to £3,488,804 and with working costs at £2,785,894 the working profit was £702,910, against £588,791 in the previous year. Dividends 9 and 10, paid during the year, absorbed £355,561, equal to 8¾%. The company on March 1 of the present year expected to pay off the balance of first mortgage debentures outstanding, amounting to £46,760. The ore reserves at the end of the year were estimated to be 7,094,000 tons, averaging 6·3 dwt. over a stoping width of 42 in., these figures being based on the standard price of gold.

New State Areas.—This company was formed in 1918 and works a deep-level property in the Far East Rand. The report for 1932 shows that 1,391,300 tons of ore was mined and that, after sorting out waste, 1,049,000 tons was crushed, yielding 511,368 oz. of gold. The total revenue amounted to £2,172,154 and working costs to £1,119,235, leaving a working profit of £1,052,919, equal to 20s. 1d. per ton milled. Dividends paid during the year absorbed £321,733, equal to 21¼%, the Union Government's share of the profits being £649,145. After paying off mortgage debentures to the value of £46,650, the amount outstanding is £139,950. The ore reserves at the end of the year, valued at the standard price of gold, were estimated to be 2,746,000 tons, averaging 8·9 dwt. over a width of 50 in.

Van Ryn Deep.—Formed in 1902 this company works a deep-level property on the Far East Rand. The report for 1932 shows that 1,152,447 tons of ore was mined and that after sorting out waste 835,000 tons was crushed, yielding 261,854 oz. of gold. The total revenue amounted to £1,112,286 and the working costs to £824,137 leaving a working profit of £288,149. Dividends paid during the year absorbed £239,378, equal to 20%. The ore reserves at the end of the year, reckoned on the standard price of gold, were estimated to be 2,500,000 tons, averaging 6 dwt. over a stoping width of 50 in.

Langlaagte Estate.—This company, formed in 1888, works a gold mine in the Central Rand. The report for 1932 shows that 1,075,869 tons of ore was mined, the tonnage milled, after sorting out waste, being 959,000. The gold recovered totalled 306,389 oz. and the total revenue was £1,318,715. Working costs amounted to £957,876 and the working profit to £360,839. Dividends distributed during the year absorbed £303,967, equal to 20%. The ore reserves at the end of the year were estimated to be 850,000 tons, averaging 6·9 dwt., over a stoping width of 44 in., these figures being based on the standard price of gold.

Witwatersrand Gold.—This company was formed in 1887 and works a gold-mining property on the East Rand. The report for 1932 shows that 815,000 tons of ore was milled, an increase of 97,500 tons over the previous year's amount. The revenue from gold produced was £674,889, while expenses totalled £668,921. A dividend equal to 2½% was paid during the year. The ore reserves at the end of the year were estimated to be 349,000 tons, averaging 4·7 dwt. over a width of 51 in., these figures being based on the standard price for gold.

Modderfontein Deep.—This company was formed in 1899 and works a deep-level property on the Far East Rand. The report for 1932 shows that 666,500 tons of ore was mined, and that, after sorting out waste, 535,400 tons was treated in the mill, yielding 258,355 oz. of gold. The

revenue from gold, silver, and osmiridium totalled £1,108,889, while the working costs were £409,321, leaving a working profit of £699,568. Dividends paid during the year absorbed £550,000, equal to 110%. The ore reserves at the end of the year were estimated to be 1,100,000 tons of an average value of 8·3 dwt. over a stoping width of 77 in. In addition there were 75,000 tons of hanging-wall leader blocks, valued at 5·1 dwt. over a stoping width of 57 in., all these figures being based on the 1932 value of gold.

Geduld Proprietary.—Formed in 1899 this company works a deep-level property on the Far East Rand. The report for 1932 shows that 1,222,760 tons of ore was mined and that, after sorting out waste, 1,018,300 tons was sent to the mill, where 325,803 oz. of gold was recovered, worth £1,395,105. Working costs came to £806,007 and the working profit was £589,098. Dividends paid during the year absorbed £547,821, equal to 37½%. The ore reserves at the end of the year amounted to 5,800,000 tons of an average value of 6·6 dwt. over a stoping width of 57 in., figures based on the standard value for gold.

East Geduld.—This company was formed in 1927 to work a deep-level property on the Far East Rand. The report for 1932 shows that 853,529 tons of ore was mined and that, after sorting out waste, 705,400 tons was sent to the mill, where 224,603 oz. of gold was recovered, worth £962,498. Working costs amounted to £648,782, leaving a working profit of £313,716. Two dividends were declared during the year, absorbing £214,500, equal to 13¾%. The ore reserves at the end of the year, calculated on the standard value of gold, were estimated to be 3,900,000 tons of an average value of 7·1 dwt. over a stoping width of 57 in.

Witwatersrand Deep.—This company was formed in 1895 and works a deep-level property on the East Rand. The report for 1932 shows that 548,000 tons of ore was milled, yielding 128,820 oz. of gold, the total revenue amounting to £545,413. Working costs amounted to 501,056, leaving a working profit of £44,357. The ore reserves, calculated at December 31 last on the standard price for gold, were estimated to be 596,000 tons, averaging 6·2 dwt. in value over a width of 51 in., as compared with 469,700 tons at 6·2 dwt. over 50 in. for the previous year.

New Kleinfontein.—This company was formed in 1894 and works a gold-mining property on the Far East Rand. The report for 1932 shows that 734,538 tons of ore was mined, an increase of 23,881 tons over the previous year, and that, after sorting out waste, 622,000 tons was treated in the mill. The gold yield totalled 123,588 oz. and the working revenue amounted to £530,497. Working costs were calculated at £562,410, resulting in a working loss of £31,913. The ore reserves at the end of the year, calculated on the standard price of gold, were estimated to be 431,000 tons, averaging 4·98 dwt. over a stoping width of 51 in., an increase of 143,000 tons over the figures at the end of the previous year. In view of the change in conditions arising from the departure from the gold standard by the Union of South Africa, a recalculation of the ore reserves was made and shows that there are approximately 2,500,000 tons available that can now be profitably mined.

Rezende Mines.—Formed in 1908, this company works a gold-mining property in Southern Rhodesia. The report for the year 1932 shows that 77,800 tons of ore was mined and sent to the mill, where 24,315 oz. of gold was recovered. Working costs amounted to £68,342 and the working profit was £66,314, against £72,567 in the previous year. Dividends paid during the year absorbed £39,375 and, after making allowances, there was a balance of £5,281 carried forward to the next account. The ore reserves at the end of the year were estimated to be 119,000 tons, averaging 8·2 dwt. in value, as against 159,000 tons, averaging 8·7 dwt., at the end of the previous year.

South Bukeru Areas.—This company was formed in 1929 and works alluvial tin property in Northern Nigeria. The report for 1932 shows that production was continued under restriction measures from January to August last, during which period 33 tons of concentrates was produced, against 102 tons during the same period in 1930 when output was not restricted. In August of the year under review production was suspended in order to discuss economies with companies of the Naraguta group. The outcome of these conversations being successful it is intended to resume quota production as from April 1. The accounts for the year show a profit of £679 and after making various allowances a credit balance of £291 was carried forward. The ore reserves in October of the year under review were estimated to be 127 tons of proved ore.

Naraguta Extended.—This company, formed in 1929, owns alluvial tin property in Northern Nigeria. The report for 1932 shows that the restricted tonnage produced was 58 tons of concentrates, against 117½ tons in the previous year, the average price realized being £81 1s. 9d. per ton, against £74 16s. 2d. Tribute operations were discontinued during the year under review, the property being placed under salaried management on September 1. The accounts show a profit of £1,076, which, added to the balance brought in, gave an available total of £4,403. After making various allowances there was a credit balance of £3,404 to be carried forward.

Nundydroog Mines.—This company was formed in 1920 and works a gold-mining property on the Kolar goldfield, India. The report for 1932 shows that 163,095 tons of ore was treated, producing 84,942 oz. of gold, while 4,663 oz. were obtained from the treatment of accumulated tailings and slags. The value of the bullion returned, including a small balance brought in, was £522,379. In accordance with the terms of agreement for the acquisition of the Balaghat property, dated April 6 of the year under review, 13,243 tons of ore from that mine was treated to yield 14,956 oz. of gold, worth £89,384. Expenditure totalled £279,492, to which must be added £49,504 payable to the Balaghat company, making a total of £328,996 and leaving a profit of £252,743, against £116,020 for the previous year. The total dividend for the year amounted to 6s. per share, equal to 60%, against 27½% in the previous year. The ore reserves at the end of the year were estimated to be 467,499 tons, averaging 14·97 dwt., an increase of 147,843 tons on the previous year's total. The feature of the year was the excellent turn of developments in the Oriental section.

Champion Reef.—This company was formed in 1921 and works a gold-mining property on the Kolar goldfield, India. The report for 1932 shows that 58,184 oz. of gold was produced from 109,470 tons of ore and 7,856 oz. recovered from re-treated tailings, making a total return of

66,040 oz. Sales of bullion brought in £386,097, the net revenue, after making various allowances, being £370,766. Working costs amounted to £242,176, leaving a profit of £128,589, an increase of £59,965 on the figures for the previous year. Dividends paid during the year amounted to 3s. 3d. per share, or 32½%, against 15% for 1931. Ore reserves at the end of the year were estimated to be 315,164 tons, averaging 13·37 dwt. in value, an increase of 76,109 tons as compared with the figures for the previous year.

Mysore Gold.—This company was formed in 1880 and works a gold-mining property on the Kolar goldfield, India. The report for 1932 shows that 88,254 oz. of gold was produced from 181,650 tons of ore milled, while 365 oz. was recovered from slags, making a total return of 88,619 oz. The bullion produced realized £517,050 and after making various allowances the net revenue was £495,025. Working costs amounted to £330,408, leaving a profit of £164,617, an increase of £42,208 on that for 1931. Dividends distributed during the year equalled 1s. 6d. per share, or 15%, against 10% for 1931. The ore reserves at the end of the year were estimated to be 405,000 tons, averaging 14·6 dwt. in value, or 40,260 tons less than the total at the end of the previous year. There was also 282,000 tons of probable ore of lower grade.

Gopeng Consolidated.—Formed in 1912, this company works alluvial tin property in the State of Perak, F.M.S. The report for the year ended September 30, 1932, shows that 1,476,500 cu. yd. of ground was treated, the total production of concentrates amounting to 311·31 tons. In addition 60·18 tons was produced on the quota of the Kent (F.M.S.) Tin Dredging Co., Ltd. The accounts show a profit of £20,816, which, added to the balance brought in, gave an available total of £49,267. Dividends paid during the year, equal to 1s. per share, absorbed £19,788, leaving a balance of £29,479 to be carried forward. During the year negotiations were concluded with the Malayan Government for prospecting the Gopeng Hill area and a licence has been exercised.

Toyo Tin.—This company, formed in 1927, works, through its Japanese subsidiaries, tin-mining property in Japan. The report for the year to November 30 last shows that 90,000 tons of ore was treated, averaging 1·22% tin oxide, 820·4 tons of concentrates being produced, for an operating profit of Yen 171,000. The accounts of Toyo Tin show a debit of £7,267, increasing the debit balance brought in to £7,273.

St. John Del Rey.—This company was formed in 1830 and works the Morro Velho mine in the district of Minas Geraes, Brazil, while neighbouring properties are being explored. The report for 1932 shows that 246,963 tons of ore was mined, 237,000 tons being treated in the mill, yielding 109,202 oz. of gold, worth, at standard value, £461,497. In addition bullion to the total par value of £27,306 was recovered from old mine workings and exploration, while silver to the value of £1,860 was also recovered. The tonnage crushed, as compared with that of the previous year, showed an increase of 15,200 tons, but the yield was lower by 5s. 1d. per ton. The premium on gold sales amounted to £181,950, increasing the total revenue to £646,342, an increase of £104,882 over that for the previous year. Working costs showed an increase of 11d. per ton, owing to the rise in exchange, but the profit was £197,618, giving, with the balance of £39,691 brought in, an available total of £237,309. Dividends paid during the year were equal to 10%, while £100,000 was transferred to capital works account and £46,339 carried forward. Certain restrictions have been placed on the remission of gold to London by the Brazilian Government. Developments on the North-West lode at Horizon 28 have not been satisfactory, but work on the main lode at Horizon 27 has shown improved values. The reserves of ore in the Morro Velho mine were estimated at 1,410,000 tons, averaging 4 oitavas and over per ton, showing a decrease of 112,000 tons, as compared with the 1931 total. There are, however, 1,200,000 tons of lower-grade ore, the payability of which depends on the price of gold. There have been good developments on the Espirito Santo ore-body and considerable reserves of mineral are now available there. The power scheme has been completed and is soon expected to be in full working. The ordinary and preference shares of the company are to be transferred to ordinary and preference stock.

DIVIDENDS DECLARED

Anglo-French Exploration.—6%, less tax, payable March 20.

Chicago-Gaika.—1s., less tax, payable March 23.

Electrolytic Zinc.—Pref. 9⅜d. (Australian currency), less tax, payable April 29.

General Mining.—2s., less tax, payable June 1.

Gopeng Consolidated.—3d., less tax, payable April 7.

Kramat Tin.—6d. (and bonus 6d.), less tax, payable April 12.

Lower Bisichi.—1½d., less tax.

Maroc.—7½d., less tax, payable April 12.

Minerals Separation.—2s., less tax, payable March 28.

Ooregum.—Pref. 1s. 6d., less tax; Ord. 6d., less tax, payable April 22.

Oroville.—1s., less tax, payable April 27.

Pahang.—Pref., 3½%, less tax, payable May 1.

Sons of Gwalia.—1s., less tax, payable April 29.

Surprise Mining.—5d., less tax, payable March 23.

Transvaal Gold Mining Estates.—1s. 3d., less tax, payable May 9.

Union Corporation.—3s. 6d., less tax.

NEW COMPANIES REGISTERED

B. D. and F. Syndicate.—Capital: £100 in 1s. shares. Objects: To acquire freehold and other properties, mines, concessions, and mining rights, etc.

China Clay Freeholds.—Capital: £10,000 in £1 shares. Objects: To acquire lands, buildings, quarries, claypits, etc.; to deal in china clay, builders' materials, etc.

Middle Witwatersrand Western Areas.—Capital: £400,000. Objects: To acquire mineral rights over 30,000 morgen immediately adjoining the farm North Potchefstroom on the Far West Witwatersrand. Directors: Raymond des Clayes, A. V. Lindbergh, and Sir Alfred Hamilton Grant.

Sudan Gold Mines.—Capital: £40,000 in 2s. shares. Objects: To acquire the mine known as Gabait gold mine, near Port Sudan, to adopt an agreement with Aurum, Ltd., to acquire any land, mines, or other properties, etc. Directors: Edward Hooper, Ernest B. Ridsdel, Cowan Shankland.