The Mining Magazine

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EDITORIAL

IN recognition of the distinguished services rendered by Sir Harold Carpenter in the advancement of metallurgical science and of his researches he has been awarded the Bessemer Gold Medal by the Iron and Steel Institute.

THE forty-fifth annual issue of Skinner's "Mining Year Book" appeared last month. This work of reference becomes of increasing value to all associated with the mining industry, containing as it does particulars of the chief mining companies operating in all parts of the world.

THE Holiday Course in Economic Geology which has been held at the Camborne School of Mines since 1919 has been arranged for the six weeks from July 6 to August 14. The course appeals to engineers and geologists home on leave, as it comprises laboratory and field work, including geological excursions, visits to mines, and field mapping.

AN invitation to hold the 1932 autumn meeting of the Institute of Metals in the United States, tendered by the American Institute of Mining and Metallurgical Engineers and the American Iron and Steel Institute, has been accepted. A provisional committee of organization has been formed in New York to prepare reception plans for the visitors and a programme and time-table have been issued.

READERS of the MAGAZINE will notice in this issue what may be called a new feature under the heading of "Notes on Practice." It is our hope that this will become a regular addition to the contents, but the realization of this aspiration will depend on the number and character of the contributions received—in other words, on the co-operation of those in a position to impart information.

THE records of the International Conference on Silicosis, held at Johannesburg in August last, have now been published by the International Labour Office. In addition to reports of the thirteen sittings of the conference, the whole of the papers presented are now available. These cover the present position with regard to silicosis in all the chief countries of the world, the state of research in South Africa being particularly well exemplified.

BY an Order of the President of the Republic, a uniform mining law has been enacted for the whole of Poland, with the exception of Upper Silesia. This law will become obligatory in Upper Silesia as soon as it has been accepted by the autonomous Silesian Seym. The Act will come into force on January 1 next and on that date the German, Austrian, and Russian laws which have hitherto been applicable in the three respective provinces of Poland will become invalid.

REFERENCE to the proposed separation of crystallography from mineralogy and petrology in the Department of Mineralogy at Cambridge was made in the MAGAZINE for February, 1929. The report of the Council of the Senate on this Department has now been issued and it has been decided that all that can be done at present is to substitute a Professorship of Mineralogy and Petrology for the present Professorship of Mineralogy, the claims for a chair in crystallography being held to be of less urgency.

THE engineering profession and particularly that branch which is concerned with power generation has lost one of its greatest exponents by the death of Sir Charles Parsons. The steam turbine—the invention of which marked the greatest advance in this field since the time of Watt—for the development and application of which so much is due to his genius and perseverance, not only revolutionized marine propulsion, but is now the means by which nearly all the electricity produced by steam power is derived.

FOLLOWING on the inaugural dinner of the Association of Scientific and Technical Institutions which was held in November last, an appeal for funds for the projected central building in London has been addressed to individual members of the constituent bodies by their respective councils and presidents. It is estimated that £500,000 will be required to defray the cost

of the complete building and it will be necessary to secure £100,000 in cash by June 24 next, when the options on the site expire. A substantial sum has been received towards this amount.

THE British Industries Fair, to which detailed reference is made elsewhere in this issue, was held last month for the twelfth successive year in London and Birmingham. It continues to increase in size and importance and this year, in spite of prevailing economic depression, is stated to have been better attended than previously. There must, however, be many visitors, especially those from abroad, who look forward to the time when it will be found possible to hold the entire exhibition in one place, as foreshadowed in the report of the committee, presided over by Lord Chelmsford, which has been considering the future scope of the Fair.

Empire Mineral Resources

Any step which can justly be held to expand the knowledge of the public in respect to the importance of our Imperial mineral wealth and which at the same time enables it to appreciate, to however small an extent, the valuable work which has been and is being done by the Mineral Resources Department of the Imperial Institute is worthy of commendation. It is pleasurable, therefore, that reference can be made to the excellent little exhibition of the mineral resources of the Empire at the Imperial Institute, which was opened last month by Mr. Amery, and at which an address was subsequently given by Sir Robert Horne. The exhibition itself, with the co-operation of the various governments, has been arranged on a geographical basis, coloured diagrams and maps being supplemented by show cases of ores, metals, and other industrial products. In addition, arranged in the appropriate colonial groups, there are displayed about twenty large-scale diorama models illustrating the winning and employment of minerals, whilst a number of cases lent by the Royal Mint afford enlightenment on coinage and casting technique. Reference should also be made to the cinema, where films illustrating mineral industries overseas are shown at frequent intervals.

In connexion with the exhibition the Department has published "A Survey of the Mineral Position of the British Empire,"[1] which, after a brief comparison of the mineral outputs of the Empire with those of the rest of the world, based on the figures for 1913 and 1928, surveys each of the dominions and colonies in turn, giving their mineral outputs and their imports, indicating the country of origin of the latter. Such work, statistical as it all is, gives nevertheless a clear insight into the dependence which all countries must place on outside sources for certain mineral supplies and shows, in addition, how near the Empire is, when considered as a unit, to mineral independence, although no particular part of the Empire can claim to be well placed in this respect. For the purposes of comparison, the minerals of industry have been divided into four groups: First, those minerals, such as gold, nickel, and tin, which the world imports largely from the Empire; secondly, minerals of which the Empire has ample supplies and an exportable surplus, such as lead, zinc, silver, and manganese; thirdly, those minerals for which the Empire depends to a certain extent on foreign countries, but of which it has great resources, as, for example, copper, aluminium, iron, tungsten, and molybdenum; and, fourthly, those minerals such as petroleum, potash, sulphur, and radium, of which the Imperial resources are comparatively small or negligible. It is comforting to reflect, however, that for the two chief mineral needs of the civilized world—coal and iron ore—the Empire can draw upon enormous resources, while liquid fuel, for which we are now so dependent on the rest of the world, must in time be increasingly supplied by the treatment of coal and oil-shale, of which ample Imperial supplies are available.

In the past, although the MAGAZINE has frequently drawn attention to the valuable work done by the staff of the Mineral Resources Department, it is probable that much of its activity has not been thoroughly appreciated. The statistical side is doubtless well known, as many have had occasion to make use of it, but it is feared that this cannot be said of the research and testing work carried out in its laboratories and it is felt that if this was known to a wider circle much greater use would be made of what must be regarded as an extremely valuable Government department.

[1] London: H.M. Stationery Office. Price 2s.

The Institution Meeting

Widely differing problems confronting the mining engineer were covered by the three papers presented at the February meeting of the Institution. Two of these, "The Sampling and Estimation of Bore-Hole Cores and Sludges," by D. K. F. MacLachlan, and "Check Sampling of Diamond Drill-Holes at the Trepca Mines, Yugoslavia," by G. F. Hatch, were concerned with the accurate interpretation of bore-hole sampling results in totally different types of ground. A digest of Mr. MacLachlan's paper, which deals with practice on the Northern Rhodesian copper belt, will be found elsewhere in this issue. The third paper before the meeting—"Clay Mining in South Devon," by Cyril Brackenbury—covered the methods used in the extraction of potter's clay from the Bovey Tracey beds, near Newton Abbot.

The intensive application of diamond drill work in the prospection of the copper-bearing rocks of Northern Rhodesia has been necessitated largely in order that deep holes might be driven to prove the ore horizons to the bottom of the synclinal folds in which they occur. During the shallower work on the fold-limbs the shot-drill was usually employed, as was the case in the sampling of the American porphyry deposits. In the deep work with the smaller-cored diamond drill core recovery is often extremely poor and the necessity for careful correlation of sludge and core samples becomes of extreme importance. The methods by which this was ensured are clearly brought out in Mr. MacLachlan's paper, the main point being that at the end of each run the drill is stopped and the hole thoroughly washed to bring up all sediment which would correspond to ground cut during the run. It might be as well, perhaps, to emphasize here the various difficulties which have to be surmounted. The author considers them to be: First, to prevent sludge being absorbed by the country rock; secondly, to prevent sludge dilution; thirdly, to ensure that the heaviest mineral grains are brought to the surface; and, fourthly, to see that sulphides are not retained on greasy equipment. Perhaps the most interesting part of the paper lies in the computation of ore values from combined core and sludge assays and the derivation of simple formulæ for the purpose. If any criticism of general practice which is evidently common to the whole of Northern Rhodesia can be made it might be to the splitting of core-samples. Such practice seems quite arbitrary and the crushing of the whole of the core would appear to be the only method of obtaining the most correct core-assay. The discussion arising from this paper at the meeting was not all relevant, especially after the main points had been clearly demonstrated by Professor Truscott and the criticism opened by him. It may be that many who are acquainted with this type of work are abroad, but here we would like to plead that more people thoroughly conversant with matters under discussion should appear at the meetings and state their views rather than contribute their arguments from the arm-chair.

Drilling in pockety, fissured, limestone presents a totally different problem from those encountered in Northern Rhodesia. Here, as was pointed out by Professor Lawn, it is difficult to get return water and consequently interpretations must often be made solely on core-samples. When these are poor it may be possible to obtain correction factors, by taking into account the toughness of the mineral being drilled, and so secure a clearer picture of the proportions of the various mineral constituents of the ore-body. How this was done in the Trepca mines, by driving along a horizontal bore, preserving the hole intact in the wall, and making careful measurements of ore proportions in the preserved channel, is well demonstrated in Mr. Hatch's paper, which is an excellent record of careful detailed work.

Finally, turning to the paper on the clay mines of South Devon, we are presented with mining problems which appear to have their solution in methods which may be described as "rough and ready," but which, by the skill which has been shown in their adaptation to the conditions at Bovey Tracey, may well be the most economical to employ. If criticism can be made of this paper it might be that offered by Mr. De la Mare, who wondered whether quicker shaft sinking might not be done by using the circular sheet sections employed by the tunnelling companies in France. The description of South Devon mining, as presented by Mr. Brackenbury, is probably the most complete available and the author is to be congratulated.

The Progress of Research

The report[1] of the Department of Scientific and Industrial Research for 1929–30, which has been issued this month, touches on several subjects of interest to readers of the MAGAZINE, as it comprises a general survey of the year's work by the Advisory Council, together with a summary of the work carried out by the research organizations connected with the Department and reports from the various industrial research associations to which the Department has given financial assistance. The investigations of the Department cover a very wide field, but the matters calling for review here are the report of the Council on the findings of the Geophysical Survey Research Committee, the summaries of the work done by the Fuel and Metallurgy Research Boards and the Geological Survey and Museum, and the report of the British Non-Ferrous Metals Research Association.

During the period mentioned the Advisory Council states that it has had under consideration a report of the Geophysical Survey Research Committee, which had been appointed to consider the possibility of initiating investigations into geophysical methods of underground surveys other than those already undertaken. The committee was impressed by the need for the formation in this country of a school of applied geophysics where research and instruction in the use of the various methods could be carried out on a proper basis, although they recognized that the subject has not been neglected and that such instruction as is within the resources of the mining and geological schools is already being given. They feel, however, that the personnel required for the proper application of geophysical survey methods should receive a training somewhat different from that of the average mining or geological student and stress the need for a competent knowledge of physics. The Imperial College of Science and Technology, with its mining and science schools, was considered to be a suitable centre for the establishment of such a school. The Committee was empowered to consult with the College authorities and the hope was expressed that effective steps toward the provision of a national school of applied geophysics will result, a hope in which we share.

The activities of the Fuel Research Board have been concentrated mainly on the hydrogenation of coal and tar, on a physical and chemical survey of the national coal resources, on the laboratory examination of coal and coke, and on work on carbonization and gas production. In view of the rapidly increasing demand in this country for liquid fuels, special interest attaches to the work on the hydrogenation of coal. The Bergius process has been investigated at the Fuel Research Station for the last seven years and it is proposed in the near future to publish complete reports of the investigations carried out there in the series of Fuel Research Technical Papers. The results so far achieved show that a yield of 120–130 gallons of motor spirit per ton of coal should be readily obtainable in a suitable plant, using a modified Bergius process. In connexion with the survey of the national coal resources, work has been proceeding rapidly in all districts where laboratory accommodation is available and a survey of the Scottish coking and furnace coals has already been published.

Metallurgical research carried out under the auspices of the Department is mainly in the realm of secondary metallurgy, the principal subjects covered being the behaviour of materials at high temperatures, light alloys, research on the production of beryllium and titanium, on steel castings, ingots, and alloy steels, on the cracking of boiler plates, and on inclusions in steel. Similarly the work of the Geological Survey and Museum has proceeded along conventional lines, although attention may be drawn to the survey of the Cornish radium mines—in connexion with which it will be remembered an article on the South Terras mine appeared in the MAGAZINE for September, 1929—and to the tests of geophysical survey methods.

The establishment of new headquarters of the British Non-Ferrous Metals Research Association has already been noted in these columns and the notification that the appeal for funds and increased subscriptions which was issued at that time has met with partial success is in these times encouraging. This association, like the Metallurgy Research Board, is concerned chiefly with secondary metallurgy, but the perseverance it has shown in endeavouring to overcome the difficulties and indifference which stand in the way of the introduction of new materials to old-established industries is worthy of every encouragement.

[1] London: H.M. Stationery Office. Price 3s. 6d.

REVIEW OF MINING

Introduction.—The general position shows little change. The official acceptance of the scheme for restricting the output of tin will give producers the breathing space necessary to weigh up the situation, but the price of this metal cannot show much advance until a reviving industry absorbs the present "visible supplies." The silver situation is assuming international proportions and there have been recent suggestions for the calling of a conference to discuss the stabilization of world values for this metal.

Transvaal.—The output of gold on the Rand for February was 800,991 oz. and in outside districts 38,946 oz., making a total of 839,937 oz., as compared with 914,576 oz. in January. The number of natives employed in the gold mines at the end of the month totalled 209,777, as compared with 209,442 at the end of January.

The report of Village Deep, Ltd., for the year 1930 shows that operations were carried on for the month of January, 1930, and that during February the mine was operated by the old organization for the Robinson Deep, Ltd., the control and management by the latter company being assumed at the beginning of March. The Village Deep reduction plant was in operation for the new company until June 30, when the recovery of gold in and about the plant was begun, the net amount recovered being £124,965. A subsidiary demolition clean-up is still going on, an extra £2,660 being recovered to the end of the year. Extraordinary general meetings are to be held following the ordinary meeting next month, when it will be proposed that the capital of the company be further reduced to £475,054 by the return of 4s. 6d. on each share in cash to the shareholders, the nominal value of the shares being thus reduced to 9s. 6d.

An offer of £100,000 10-year 7% Convertible Notes has been made to shareholders of the Luipaard's Vlei Estate and Gold Mining Company, to be secured by a floating charge on the assets. The new notes will be convertible into shares at 4s. per share at any time until December 31, 1933.

A winding accident in the South Vertical shaft of the Randfontein Estates Gold Mining Company towards the middle of last month caused material damage to the shaft and winding equipment. No casualties occurred and, although output was restricted, the shaft was in commission by the end of the month.

The board of the Anglo American Corporation, which owns large interests in diamond and other mining concerns, has decided not to declare a dividend on the ordinary shares. A year ago 22½ per cent. was declared.

Diamonds.—The output of diamonds from the Union of South Africa during 1930 was 3,163,591 carats, valued at £8,340,719, as compared with 3,661,212 carats, valued at £10,590,000, in the previous year. Mined stones totalled 2,242,460 carats and the values of all stones showed a marked decrease. Namaqualand's production was 142,125 carats, but the value per carat for these stones increased by 48s.

It is reported from the Crown Diamond Mining and Exploration Company that in driving the main cross-cut at the 1,100 ft. level the pipe was met with 270 ft. south of the vertical projection from the 780 ft. level intersection. At the end of February the cross-cut was 122 ft. in blue ground.

Southern Rhodesia.—The output of gold from Southern Rhodesia during January was 45,677 oz., as compared with 46,485 oz. for the previous month and 46,121 oz. for January, 1930. Other outputs for January were: Silver, 6,606 oz.; copper, 115 tons; coal, 65,075 tons; chrome ore, 11,266 tons; asbestos, 4,430 tons; mica, 6 tons.

The report of the Wanderer Consolidated Gold Mines, Ltd., for the three months ended December 31 last shows that the de-watering of the Ashton mine has been completed and that development operations have been commenced in that section.

Northern Rhodesia.—During the quarter ended December 31 last the deepest bore-hole on the property of the Mufulira Copper Mines was completed. This hole, No. 29, cut the second ore-body at a depth of 3,193 ft. and showed a true width of 8·5 ft. of ore carrying 2·32% copper. At 3,280 ft. the third ore-body was reached and this was found to be 43 ft. thick, carrying 4·38% copper. Work on shaft sinking is proceeding, the Selkirk shaft having reached 202 ft., being lined to this depth.

A circular to shareholders in Rhodesian Selection Trust, Ltd., states that an agreement has been concluded between that company, the Bwana company, the British South Africa Company, and Mufulira Copper

Mines whereby the whole of the Selection Trust's mining properties in Northern Rhodesia are transferred to the last named company. Rhodesian Selection Trust maintains its interest of approximarely two-thirds in the properties in the form of shares in Mufulira Copper Mines, Ltd. For the present the Mufulira company has decided to complete only the first unit of its plant. This will treat 1,500 tons of ore per day and will reduce the immediate capital requirements of the company by about £1,500,000.

Reference was made here last month to the increased unemployment due to the curtailment of development operations by the Northern Rhodesian copper mines. The Governor of the colony, on meeting a deputation of unemployed, promised certain measures of relief and recommended that unabsorbed men should leave the territory, for which government assistance would be given.

A circular to shareholders of the Rio Tinto company states that an extraordinary meeting is to be held this month when it will be proposed that an issue of £2,000,000 Redeemable Debentures be made. In particular the company proposes to invest in the forthcoming issue of 7% convertible debentures of the Rhodesian Congo Border Concession (now known as the Rhokana Corporation, Ltd.), but funds are also required to enable it to continue its policy of development and expansion outside Spain.

Nigeria.—During the year ended September 30 last the output of tin concentrates of Lower Bisichi (Nigeria) Tin Mines was 89 tons, as compared with 76 tons in the previous year, the average value per ton realized being £98 14s. 2d., against £143 13s. 2d. The profit for the year was £319, which increased the balance carried forward to £2,336.

Australia.—The present low prices for metals continues seriously to affect the Australian producers, the North Broken Hill Company announcing its inability to declare a dividend for the present quarter. In addition, the Zinc Corporation has given statutory notice that operations will be suspended in mid-April unless conditions improve.

A circular to shareholders of the Wiluna Gold Corporation, issued this month, states that the underground section is in satisfactory operation. The ore-bins have been filled and the testing of the plant commenced. The grinding section was started on March 2 and the flotation, roasting, and cyanide sections will follow during the month. The synchronization of units will proceed as quickly as possible. The company also announces that a favourable report on the plant and property has been received from Mr. Carl O. Lindberg, who has made an examination on behalf of the New Consolidated Gold Fields, Ltd.

A bore-hole from the 600 ft. level of the Ivanhoe-Horseshoe section of Lake View and Star, Ltd., has been put down to prove the continuation of the Ivanhoe-Boulder lode into the Horseshoe mine, where it has not been previously worked at this level. The hole has been advanced to a total depth of 141 ft. and ore assaying 36s. per ton was encountered between 115½ and 116 ft., while from 117 ft. to 117½ ft. ore assayed 50s. per ton and from 121 ft. to 122 ft. 52s. per ton.

A company, which includes on its board Mr. H. E. Vail, consulting engineer to the Wiluna Gold Corporation, and Mr. D. F. McAulay, vice-president of the Chamber of Mines of Western Australia, has been formed to re-open the Yuanmi mine, on the East Murchison goldfield.

The Arbitration Court, examining the rates of pay of miners in Western Australia, has made a reduction of 10% in mining wages. This reduction came into force on March 2.

India.—A serious rock-burst occurred at the beginning of the month in Bullen's stopes of the Ooregum mine. It is expected that the output will be temporarily restricted.

The results of operations on the Balaghât mines have been such that it has been decided to pay no dividend on the preference or ordinary shares.

Malaya.—The report of Gopeng Consolidated for the year ended September 30 last shows that 847 tons of tin concentrates was recovered during the year from the treatment of 1,956,000 cu. yd. of ground, as compared with 962 tons from 2,097,100 cu. yd. in the previous year. The total revenue was £81,419 and the working profit £57,329, as against £90,642 the year before. With the balance brought in there was available for distribution a sum of £86,520. Dividends absorbed £54,418 and the balance of £32,102 was carried forward.

A circular to shareholders in Sungei Besi Mines, Ltd., gives notice of a call of 3s. per share for the purposes of the company and particularly for the development of the Village areas. Notice is also given of the formation of a new company, to be known as Pelepah Tin Dredging, Ltd., which will

take over the area of 1,092 acres in the State of Johore, the options for a sub-lease over which are held by the Sungei Besi company. The new company has a nominal capital of £200,000, in 5s. shares, the issued capital being £175,000, £25,000 of which will be issued to Sungei Besi Mines in return for the transference of their rights in the property. In addition Sungei Besi will borrow £125,000 and will apply for 500,000 shares in the new company. The main selected section of the Pelepah area covers approximately 974 acres containing 49,682,000 cu. yd., averaging 0·49 katty, the average depth being 31·6 ft. Steps have been taken for the building of a dredge and it is estimated that with tin at £120 per ton the annual mine profit will be £25,950.

Brazil.—With the declaration of the ordinary dividend usually made at this time of the year, the directors of the St. John del Rey Mining Company have announced that they propose to pay a centenary bonus of 2½%, which will make a total distribution of 12½% for the year.

Panama.—Following the arrival of Mr. Hugh F. Marriott in the country, the Panama Corporation have announced that the three plants at the Remance mine, El Mineral, and Cana (Sabalo workings) will all have commenced production by the end of this month.

Mexico.—The scheme for the reorganization of the share and debenture capital of the West Mexican Mines, approved in November last, has since been confirmed by an order of Court. An offer is now being made to shareholders of 500,000 "B" shares of 2s. each.

Canada.—The International Joint Commission, set up to assess the damage done by deleterious fumes from the Trail Smelter of the Consolidated Mining and Smelting Company to orchards and farms in the State of Washington, has made an award of $350,000 against the company.

Wales.—An extraordinary meeting of the English Crown Spelter Company will be held at Swansea this month, when an offer of £50,000 for the goodwill, leasehold and other property, and fixed plant and machinery of the works at Swansea, made by Austral Development, will be considered. The sale, if carried out, is expected to provide a balance, after payment of all debts and liabilities,which will permit of a distribution of 3s. per share.

Cornwall.—During 1930 the profit of Tehidy Minerals was £8,035, which, with the amount of £9,384 brought in, gave an available total of £17,419. Of this amount £5,000 has been placed to reserve and £7,350 distributed as a dividend, equal to 2⅓%, leaving a balance of £5,069 to be carried forward.

Borax Consolidated.—The profit of Borax Consolidated, Ltd., for the year ended September 30 last was £163,447. After adding the balance of £208,675 brought in and making various appropriations, allowance for debenture interest, and preference dividends there remained a balance of £191,249, which was carried forward. The company has acquired an interest in an important potash company in the United States. The Rasorite mine, in California, is now in full operation, as is the new refinery at Wilmington.

British South Africa Company.—During the year ended September 30 last the profit of the British South Africa Company was £409,762, which, with the balance of £686,724 brought in, gave an available total of £1,096,485. A dividend of 1s. 3d. per share absorbed £449,432 and the balance of £647,053 was carried forward. An account of mining activities and results in Rhodesia by Mr. E. H. Clifford accompanies the report. In it he states that, apart from the discovery of rich ore on the Chingola grant of the Rhodesian Congo Border Concession, work on the various concessions has not during the year under review resulted in any other valuable discovery.

London Tin Corporation.—The report of the London Tin Corporation, Ltd., for the year ended September 30 last shows a profit of £274,290, as compared with £137,035 in the preceding year. After adding the sum of £48,598 brought forward, there was an available balance of £312,752, of which £118,941 was distributed as dividends.

Tin.—The international scheme for the regulation of the production and export of tin, which, after recognition in principle by the home government, was finally agreed to this month, recognises a basic figure of 145,000 tons. The initial quotas of the four countries coming into the scheme at its commencement have been assessed at 125,770 tons, distributed as follows: Malaya, 53,853 tons; Bolivia, 34,260 tons; Netherlands East Indies, 29,910 tons; Nigeria, 7,750 tons. The scheme took effect as from the beginning of March.

THE RANDFONTEIN ESTATES

By G. H. BEATTY

The author, who is Consulting Engineer to the Johannesburg Consolidated Investment Company, Ltd., describes the operation of this well-known producer on the Far West Rand.

HISTORY.—Gold mining in the Randfontein area has been associated with the name of the late Sir J. B. Robinson from the earliest prospecting operations until 1917, when the control was taken over by the Johannesburg Consolidated Investment Company, Limited, which company is under the permanent chairmanship of Mr. S. B. Joel. Fergusson, and Van Hulsteyn. The Randfontein Central Gold Mining Company was formed in 1907 to acquire the Block A, Mynpacht, and West Mines and subsequently absorbed the remaining abovementioned properties. Finally in 1924 the Randfontein Estates Gold Mining Company and the Randfontein Central Gold Mining Company

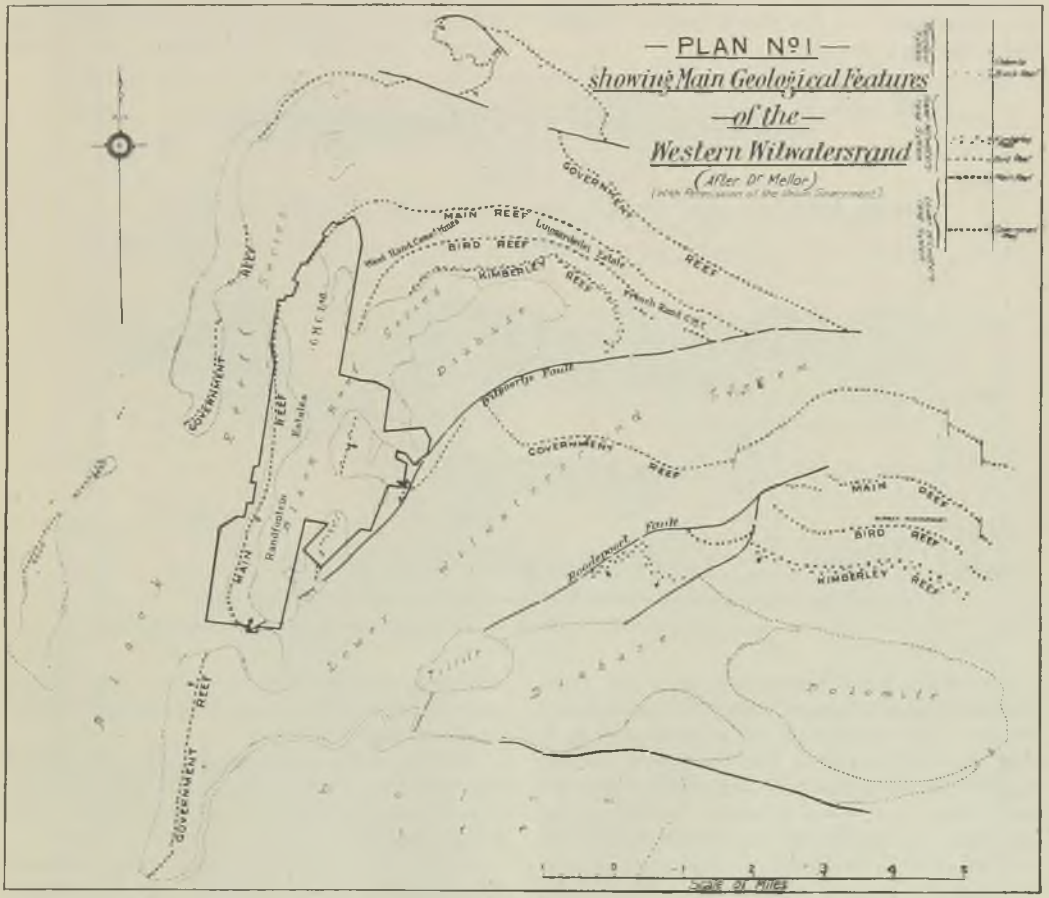


FIG. 1.

The Randfontein Estates Gold Mining Company was formed in April, 1889, as a finance company and a long sequence of flotations, divisions, and amalgamations followed. Prior to the Boer War all the following mining companies were registered and some had started milling operations: Stubbs, Porges, South, North, Robinson Randfontein, Block A, Mynpacht, West, were amalgamated, the latter company having acquired the Randfontein Deep Gold Mining Company's assets in 1920.

The mine to-day handles approximately one-twelfth of the total tonnage of the Witwatersrand goldfields. Its 600-stamp mill is one of the largest crushing units under one roof in the world. From the commencement of operations until December 31, 1930,

the company has milled 49,843,434 tons of ore, from which 14,019,022 oz. of fine gold have been recovered, valued at £59,549,020.

PROPERTY.—The present holdings of the company consist of freehold rights over an area of 30,540 acres and the gold mining rights under 1,838 acres of mynpachts and 2,690 gold mining claims. The township of Randfontein, situated 27 miles west of Johannesburg, is on the mine property.

GEOLOGY.—The Upper Witwatersrand System—which includes all the reefs which carry gold in large quantities on the Witwatersrand—underlies the major portion of the area held by the Randfontein Estates Gold Mining Company.

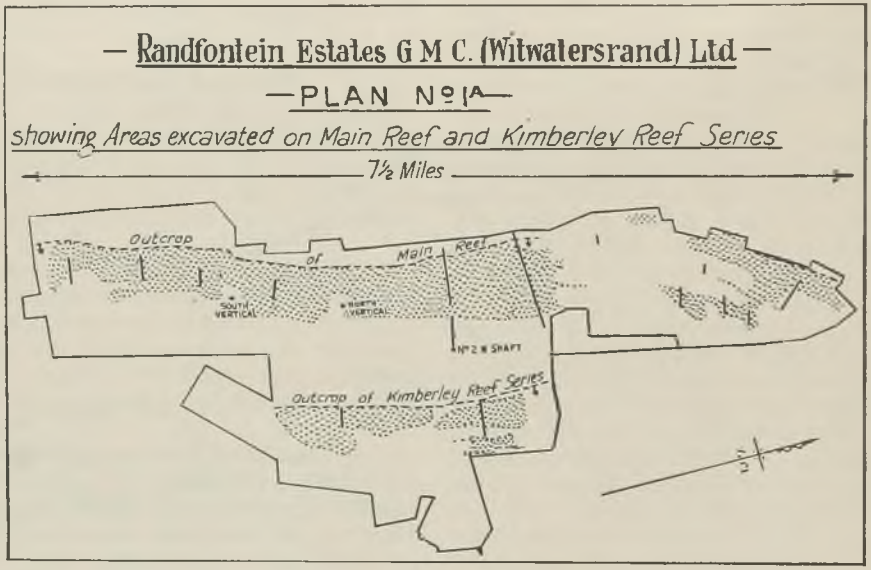


FIG. 1*a*.

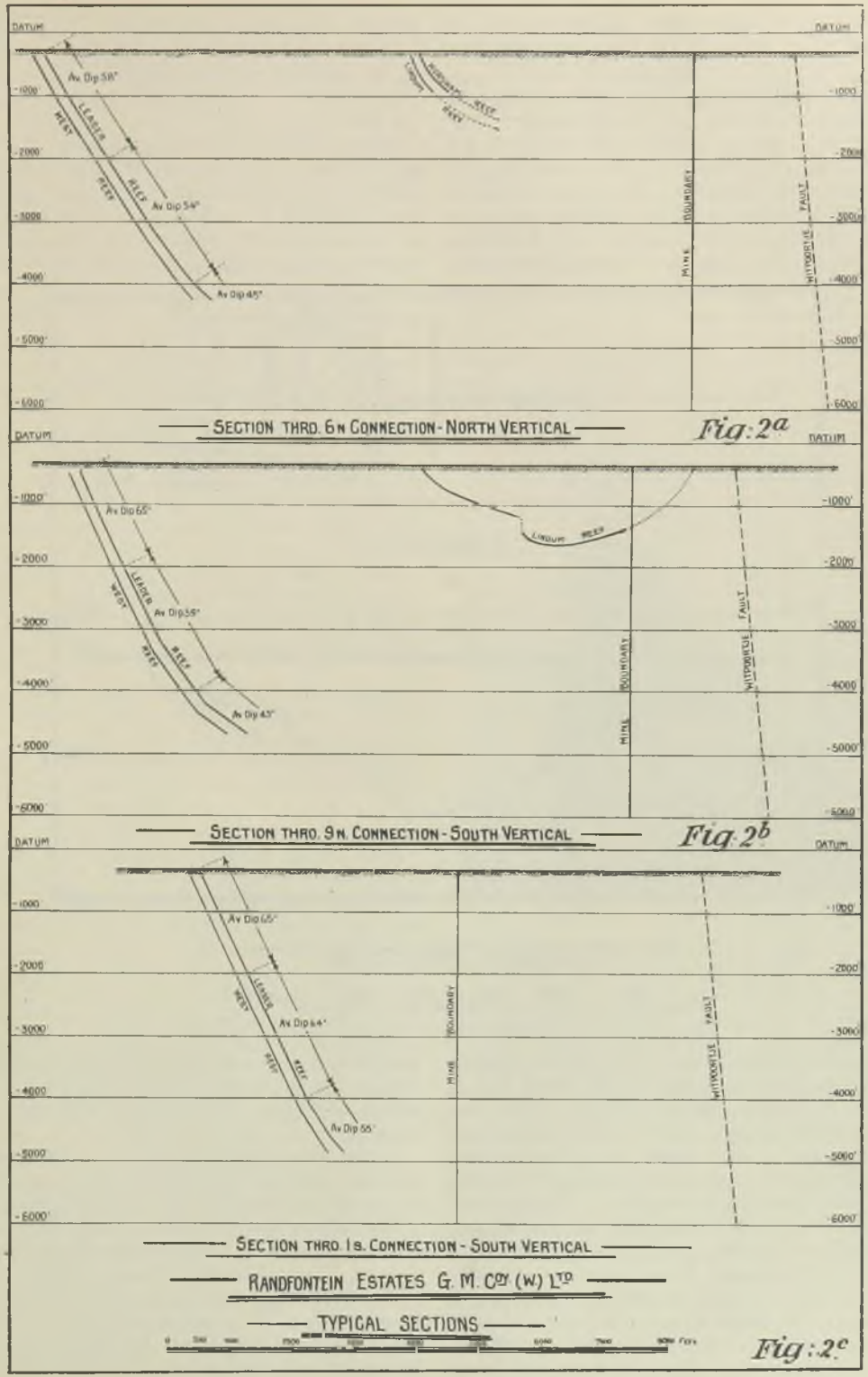
The Main Reef Series, which is the most important gold carrier in the Witwatersrand System, has a general strike east and west and dip to the south, but where this Series enters the Randfontein property from the east there is a bend resulting in the strike changing to north and south with the dip to the east; this strike and dip persist through the greater portion of the property. Near the south boundary, however, the strike changes to east and west with the dip to the north until the Series is cut off by the Witpoortje fault. (See plan after Dr. Mellor, Fig. 1.)

The Witpoortje fault, one of the major faults on the Witwatersrand, dips almost vertically and the country to the south-east of this fault, and between it and the Roodepoort fault, is upthrown approximately 7,000 ft., with the result that the Main Reef Series between these two faults has been eroded. To the north-west of the Witpoortje fault are the Randfontein Estates, the West Rand Consolidated Gold Mining Company, Luipaardsvlei Estate, and the French Rand Mines.

South of Randfontein the Witwatersrand beds are overlain by a thick covering of dolomite, which makes prospecting difficult and costly, so that very little work has been done to ascertain whether the gold-bearing reefs are within economic reach. On portions of the Randfontein area the Witwatersrand Series is overlain by unconformable strata of much more recent deposition, namely, the Black Reef Series, which has suffered considerable erosion, but when present is found in certain areas to contain payable conglomerates.

The following conglomerates are worked on the company's property:—The Black Reef, the Kimberley Series, the Bird Series, the Main Reef Series.

Black Reef.—This is a comparatively unimportant source of gold and the values are irregular. The reef lies horizontally at shallow depths and is, therefore, easy to prospect. Several areas of this reef have been proved and are now being mined at a profit. Owing to the shallow depth the conglomerates have become oxidized and present a characteristic appearance owing to solution of the original pyritic content which has left the body honeycombed; this is usually an indication of fair values. The width of the conglomerate found in the Black



FIGS. 2*a*, 2*b*, and 2*c*.

Reef Series varies from a few inches to several feet and gold contents up to a few ounces per ton are occasionally found.

Kimberley Series.—This series comprises a great thickness of conglomerates and quartzites, the majority of which have no economic importance. Two horizons at Randfontein, however, show a sufficient concentration of gold to warrant exploitation—these are known locally as the Horsham (the upper bed) and the Lindum Reefs (the lower bed). The Horsham Reef is some 150 ft. above the horizon of the Lindum Reef, which latter is approximately 5,000 ft. above the Main Reef horizon. (See Sections Figs. Nos. 2a and 2b.) These reefs are characterized by high pyritic content and include rounded pyrite nodules termed buckshot. The pebbles in the reef vary in colour from black to milky white or colourless quartz, and pebbles of chert are common. The occurrence of buckshot pyrites is often an indication of good values. The Kimberley reefs form a trough on this property, the bottom of which pitches north; both sides of the trough are being mined. (See Plan and Section Fig. No. 3.) The reefs vary in thickness, but are worked at an average stoping width of 49 in., and the average yield from this series is 4 dwt. per ton.

Bird Reef Series.—This horizon of conglomerates of the Witwatersrand Series is 1,500 ft. above the Main Reef Series; it is a wide reef and is worked at a stoping width of approximately 5 ft. The gold is not regular in its occurrence in that it changes horizons with no apparent structural alteration in the appearance of the conglomerates, which occasions difficulty in following the value.

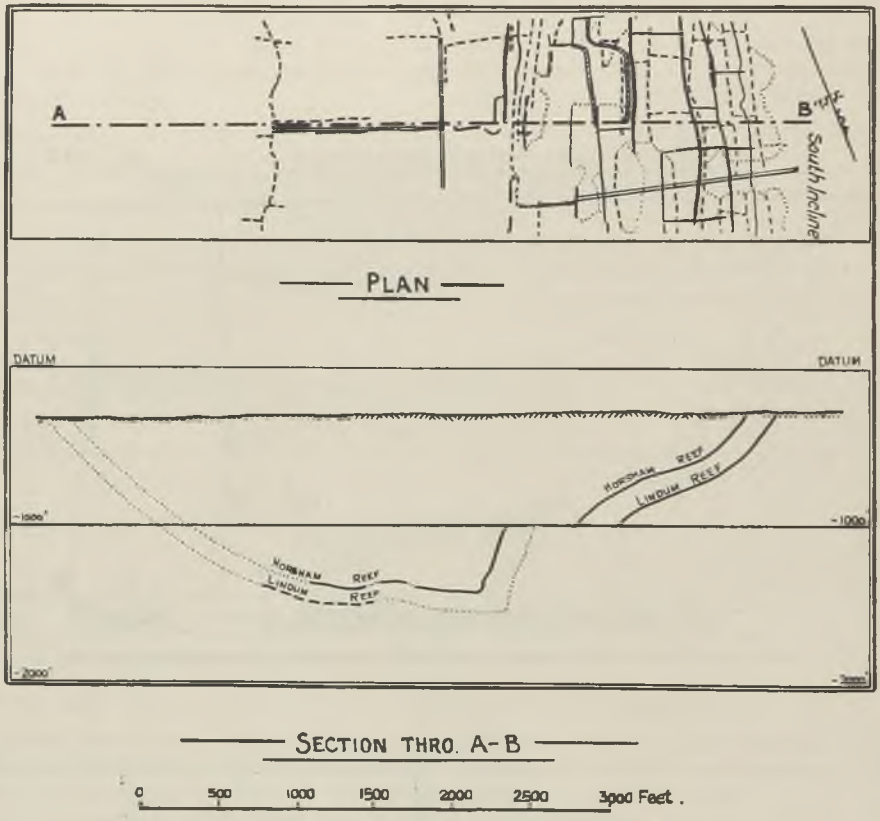


FIG. 3.—PLAN AND SECTION OF BATTERY REEF WORKINGS.

Main Reef Series.—This—the most important—series has a strike of over seven miles on the Randfontein Estates' property.

The Main Reef Leader, which is of the greatest economic value in the Near West, Central, East, and Far East areas of the Witwatersrand, loses its value west of Roodepoort; its normal position between the Main and South Reefs is marked only by an occasional pebble in the Randfontein

area. The two other reefs of this series are worked, namely, the South Reef (locally known as the Leader) and the Main Reef (known as the West Reef).

The South Reef on this property has an average thickness of 8 in. and frequently separates into two or three bands; the bottom band, which carries the highest values, seldom exceeds 2 in. in width and is often only represented by a carbon leader in which an occasional pebble occurs. This carbon leader, which is composed of small granular particles of carbon, appears like a pencil line and is the only indicator on occasions of a reef carrying a high concentration of gold which is visible to the naked eye. The pebbles of the South Reef are generally well rounded glassy quartz of a smoky or whitish colour set in a grey siliceous matrix.

The Main Reef, which lies 108 ft. below the South Reef, consists of a medium pebbled conglomerate averaging 12 in. in width, but varying from several feet to an ill-defined stringer; in the latter case the gold content is low. The pebbles are well-rounded black or white quartz with some chert pebbles of angular shape. The matrix is a dark pyritic quartzite.

Below the Main Reef there are several bands of conglomerates which, although almost barren of gold, have definite characteristics, making their identification possible and thus their occurrence is of some use as a means of locating horizons.

The Main Reef Series has a dip approximating 57° between surface and a depth of 4,000 ft., and it is apparent, therefore, that if this dip had persisted the ore available for extraction would be limited by the depth to which it could be worked owing to conditions of temperature and pressure. It may be mentioned that mining is being carried on in the Central Rand area at a depth of more than 7,500 ft. below surface. Fortunately, the geothermic gradient on the Witwatersrand is flat, being 1° F. per 220 ft. descent, but owing to the abundant use of water as a preventative against the formation of dust the mine air approaches saturation. Pressure, whilst cheapening the cost of rock breaking, increases the cost of the support of workings and constant care is necessary to avoid or minimize the effect of rock-bursts.

As the Kimberley Series has been proved to occur in the form of a trough (Fig. No. 3), the bottom of which is 1,700 ft. below surface, the depth of the underlying Main Reef Series can be deduced within certain limits, depending on the thickness of the strata between them. All available data have been closely studied, and it would appear that a great proportion, if not all the Main Reef Series west of the Witpoortje fault, occurs above the horizon at which depth alone would prevent exploitation. This theory is being substantiated on the Randfontein Estates' property by the progressive flattening of the series apparent in the lower levels of the mine. To illustrate this sections have been prepared (Figs. Nos. 2a, 2b, 2c).

MINING.—As has been mentioned, the property is an amalgamation of many mines. When the Johannesburg Consolidated Investment Company took over the administration

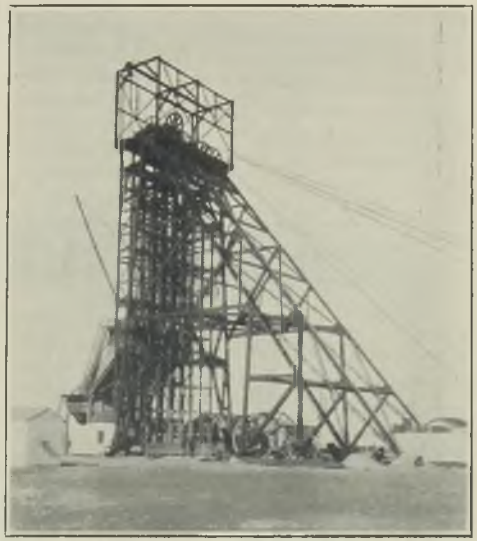


FIG. 4.—HEAD-GEAR AT NO. 2 NORTH SHAFT.

in 1917, mining operations were served through the shafts sunk by the independent mines. These in the higher grade section of the property covered a strike of 17,000 ft. of the Main Reef Series. Hoisting and pumping operations were conducted through eleven shafts, comprising two main inclines, five sub-inclines, three main verticals, and one compound shaft. The eleven shafts were served by 20 hoists, 57 engine drivers, and a host of skipmen, banksmen, and shaft timbermen. In 1919 1,236,000 tons were hoisted through these shafts at a cost of 2·363 shillings per ton from an average depth of 2,300 ft. The water pumped from the area averaged about 3,750,000 gallons per day; the pumping plant consisted of 93 units situated in 33 pump stations. Pumping costs for the year 1919 equalled 2·15 shillings per

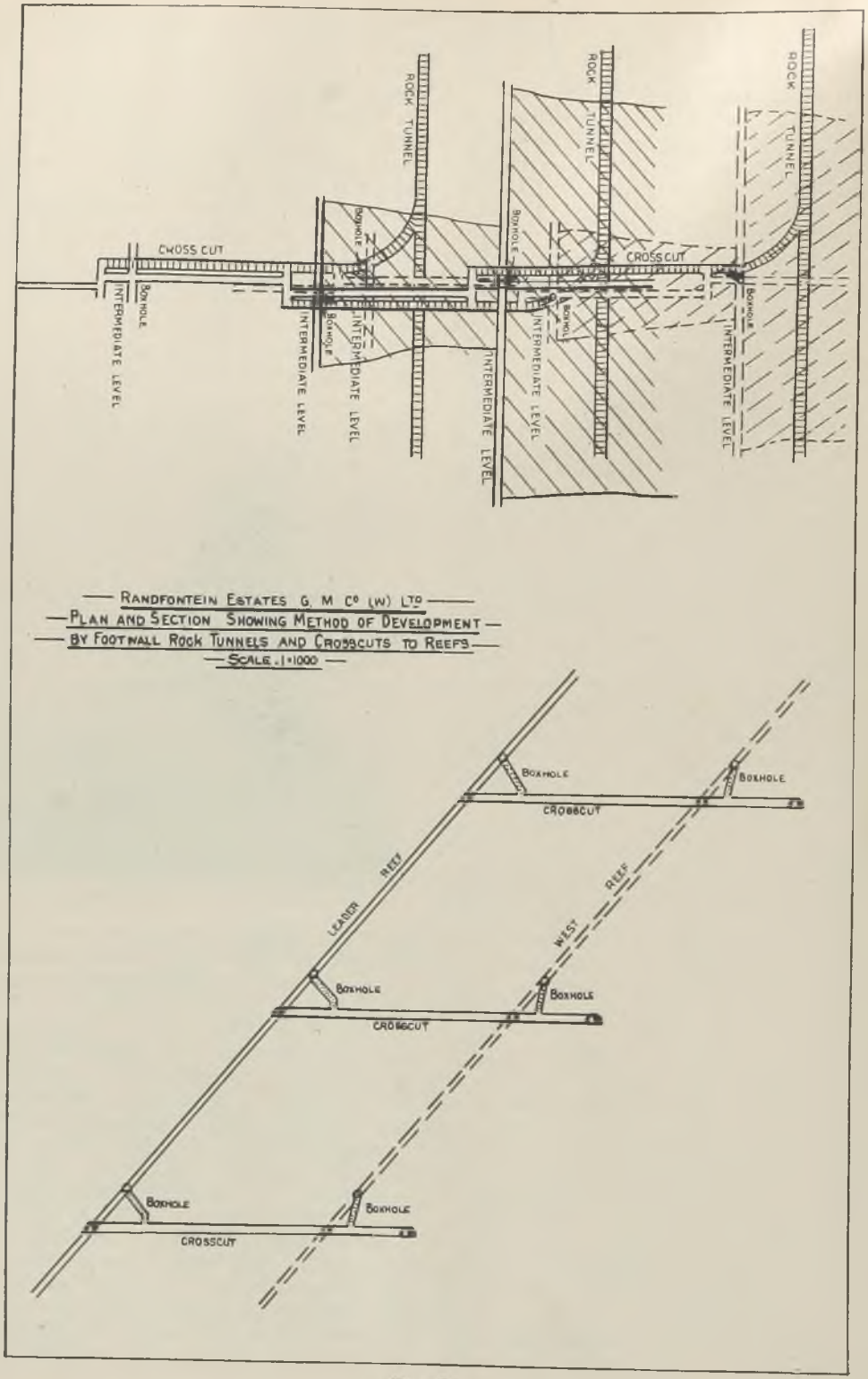

ROCK TUNNEL
CROSS CUT
INTERMEDIATE LEVEL
BOXHOLE
CROSSCUT
RANDFONTEIN ESTATES G. M Co (W) LTD
PLAN AND SECTION SHOWING METHOD OF DEVELOPMENT
BY FOOTWALL ROCK TUNNELS AND CROSSCUTS TO REEFS
SCALE. 1×1000
LEADER REEF
WEST REEF

FIG. 5.

ton crushed. The condition of the shafts and the pumping plant was deplorable, as many of the shafts, pump stations, sumps, etc., were in caving ground. With the change of control in 1917, it was apparent that a complete reorganization was essential and no time was lost in starting two modern shafts to eliminate nine old ones, and to centralize the pumping plant in one station with four centrifugal units, each having a capacity of 80,000 gallons per hour. The reorganization was completed in four years, and in the meantime development and mining methods had undergone a complete change.

At the present time ore is being won from the four different reef series in the following proportions :—Black Reef Series, 2·7% ; Kimberley Reef Series, 20·1% ; Bird Reef Series, 2·7% ; Main Reef Series, 74·5%. he south ern half of the Main Reef Section of the mine is of most economic importance and has, therefore, been most extensively mined. This section has a strike of 19,000 ft. north and south and the reefs dip steeply to the east and tend to flatten in depth, as shown in the sections. Compared with other mines of the Rand, the strike and dip are regular, the distribution of gold is even, and faults and dykes are of minor importance.

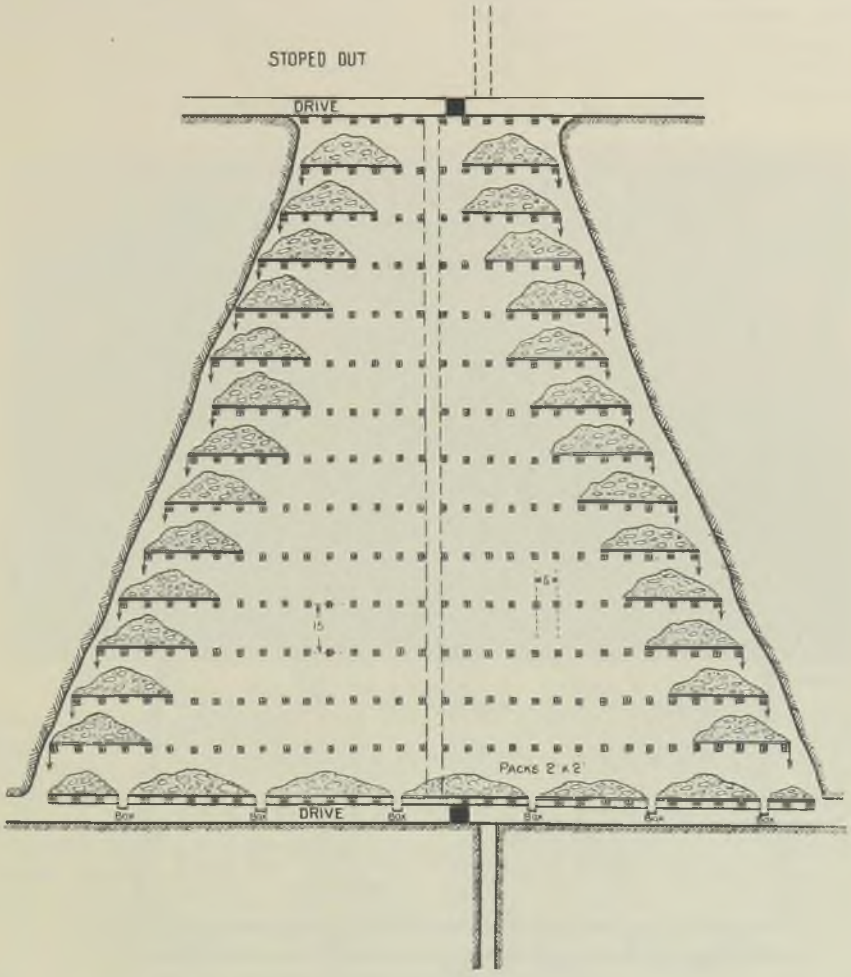


FIG. 6.—PLAN SHOWING METHOD OF OVERHAND STOPING AND SUPPORT OF WORKINGS.

The Main Reef Section is served by three main vertical shafts. Two are of the rectangular type of shaft 27 ft. 9 in. by 12 ft. 1 in. outside timbers, and are approximately 4,700 ft. deep ; the third shaft, sunk for the purpose of ventilation, and to carry the pump columns and cables, is a circular shaft, 22 ft. in diameter and 3,421 ft. deep.

Owing to the desirability of adding to the hoisting capacity of this section, a fourth shaft is now being sunk. This shaft, which

is a seven-compartment rectangular type, 42 ft. long and 8 ft. wide, was sunk by the old Randfontein Deep Company to a depth of 2,083 ft. and was abandoned in 1912 when that company ceased active mining operations. In the interval the shaft had collapsed, but has now been repaired and sunk to below 3,600 ft. The shaft will reach its ultimate depth of 4,600 ft. in the first half of 1931, and will then become the third main service shaft for the southern portion of the Main Reef Section of the mine. The headframe at this shaft (129 ft. high) is shown in Fig. 4. These three shafts will readily handle the required tonnage and material.

Development is being carried out on the northern sections of the Main Reef Series, but at present they may be considered as unimportant from a tonnage production standpoint.

The method of working the ore-bodies is by means of haulages driven approximately

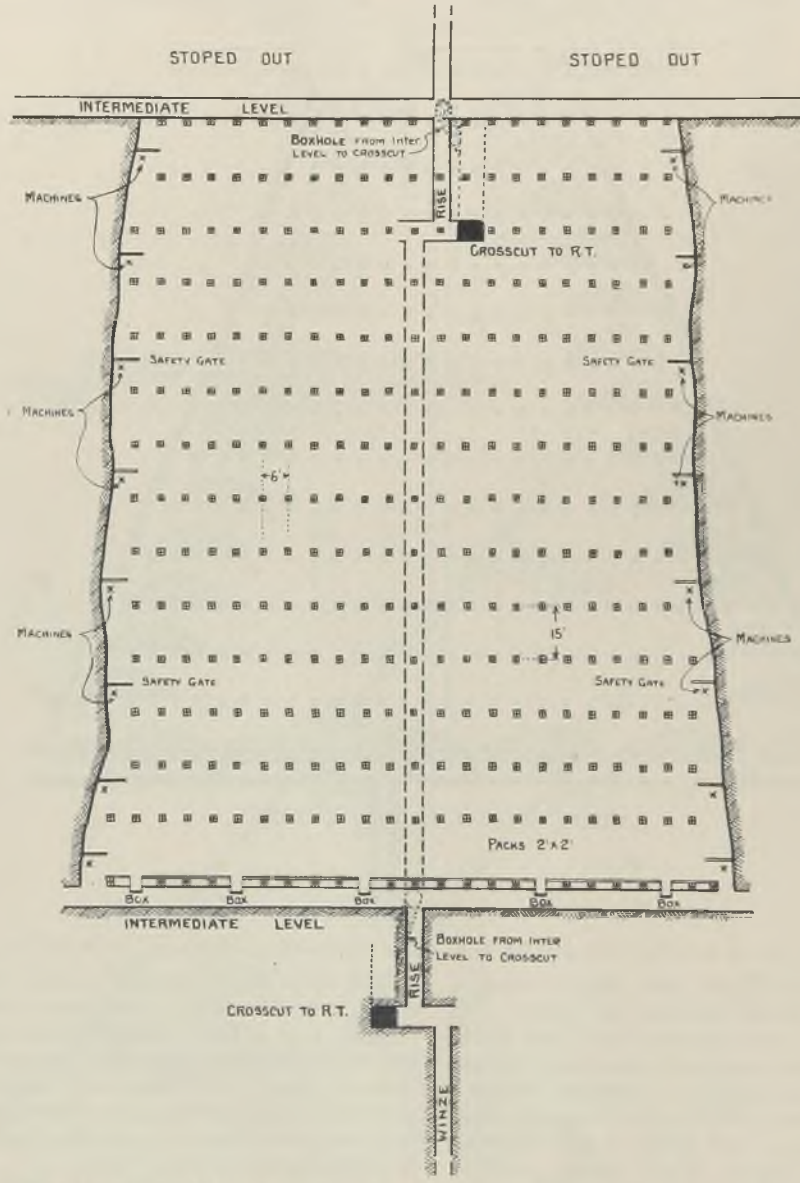


FIG. 7.—PLAN SHOWING METHOD OF STOPING WITH SAFETY GATES AND SOLID CHOCK SUPPORT.

70 ft. in the footwall of and parallel to the Main Reef. These are 9 ft. by 9 ft. and are driven at 200 ft. vertical intervals. Cross-cuts from these haulages are run out to the two reefs at intervals of 480 ft. along the strike. The South Reef is approximately 180 ft. in the hanging wall of the Main Reef. The reefs, the dip of which has flattened from 70° to less than 50° at the present depth of working, are developed by raises and winzes. (Fig. 5.)

A cross-cut raise at 50° is risen from the cross-cut to the reef striking it 30 ft. above the level; this serves as a storage bin, and also as the starting point of the intermediate reef drives which are advanced with the stope faces. In addition, a travelling way for men and material is put in from the haulage to the intermediate drives. The connexions between the levels are opened out into stopes, the pitch at which the working faces was carried being about 50° from the horizontal. (Fig. 6.) A pitch approaching true breast stoping is now being tried with promising results. (Fig. 7.)

Stoping.—Stoping is by means of hand-held jackhammer drills using $\frac{7}{8}$ in. round hollow steel and drilling 3 ft. 6 in. holes, which are blasted with 50% gelignite. These operations are carried out from loaded stulls supported on chock packs built 2 ft. by 2 ft. with 4 in. roughly squared timber. The stulls are 15 ft. apart on the dip, and their construction is varied to suit the condition of the hanging wall.

The broken ore is hand-trammed by small cars on the intermediate drives and dumped into the cross-cut bins, from where it is collected in 4-ton side-discharge hoppers drawn by 10-ton trolley wire locomotives, which take the ore to the shaft bins via the haulages.

The Kimberley Series is served by two three-compartment incline shafts dipping 45° to the east and 4,800 ft. apart. The method of mining is similar to that on the Main Reef Section except that, owing to the irregularity of the pay zones and as the workings are at no great depth, development for the most part has been carried out in the reef; the dip is flatter and no stulls are required in the stopes.

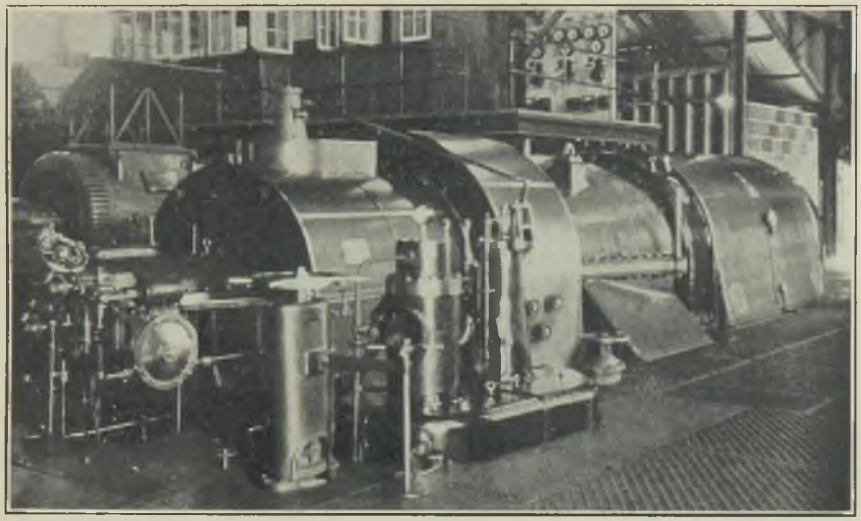


FIG. 8.—CENTRAL POWER STATION: 12,000 K.W. SET.

The Black Reef Series lies horizontally, and as the average gold carrier is very narrow this reef is mined by a resuing method, the milling width averaging 20 in.

During the year 1930 the following work was accomplished in all sections:—Shaft Sinking, 4,077 ft.; Haulage ways, 18,965 ft.; Drives, 18,962 ft.; Cross-cuts, 24,539 ft.; Winzes and raises, 35,940 ft.; Ore Passes, etc., 1,222 ft.; Drives and Winzes in Black Reef Workings, 9,135 ft.—total, 112,840 ft. Total tonnage broken, 3,171,651 tons. Areas stoped—by jackhammers, 199,204 fathoms; by hand labour, 22,438 fathoms—total, 221,642 fathoms.

CENTRAL POWER STATION.—The electrical power and a proportion of the compressed air power that is used on the mine is generated at the company's Central Power Station.

(*a*) *Boiler Plant.*—The plant comprises:—21 Babcock and Wilcox land type boilers, 17

of which normally are under steam. The boilers are provided with chain grates, superheaters, and economizers. The working-pressure of the boilers is 180 lb. per sq. in. and the duty of each boiler is 20,000 lb. of steam per hour from and at 212° F. when firing with a mixture of coal consisting of 40% nuts and peas and 60% of dross. The steam is delivered from the superheaters at 600° F.

The water feed system consists of a Weir Optimum De-Aerator plant, capable of reducing the dissolved oxygen in the feed water to approximately ·05 cc. per litre and which can treat 400,000 lb. of feed water per hour, and three turbine feed pumps and two Weir vertical pumps with an overall duty of 41,000 gallons per hour.

Induced draught is by means of eight Sirocco fans, four each of 120,000 cu. ft. and four each of 230,000 cu. ft. capacity at a water gauge of one inch.

Coal storage is in external bunkers with a capacity of 2,000 tons and internal bunkers with a capacity of 500 tons. The distribution of coal to the boilers is by means of conveyors.

The coal consumption of the plant is approximately 500 tons per day, the average cost of which is 11·62 shillings per ton; 6·87 lb. of steam per lb. of coal is produced, and 1·99 lb. of coal consumed per k.w. hour generated. The load on the Station varies from 12,000 to 23,000 k.v.a., and the average demand is approximately 18,000 k.v.a.

(*b*) *Generating Plant.*—The following generators are installed: One 12,000 k.w. Parsons reaction turbo generator (Fig. 8), one 6,000 k.w. Westinghouse Rateau turbo generator, two 6,000 k.w. Parsons reaction turbo generators, and three 2,000 k.w. Parsons Tandem reaction turbo generators, these latter being held in reserve.

Each turbine is equipped with a separate condensing plant, the auxiliaries of which are electrically driven. The cooling water for the majority of these units is taken from a cooling lake of 77,000,000 gallons capacity; approximately 8,000 gallons per minute are required by the station.

Power is generated at 6,600 volts, 50 cycles, 3 phase, at an average power factor of 0·87 at the power station bus-bars and distributed through underground cables to ten sub-stations varying in capacity from 1,500 to 10,500 k.v.a., and in total 39,000 k.v.a. The pressure is generally reduced at the sub-stations to 2,200 volts for local distribution, with the exception of the Central Mill Reduction Works, at which the power is used at 550 volts.

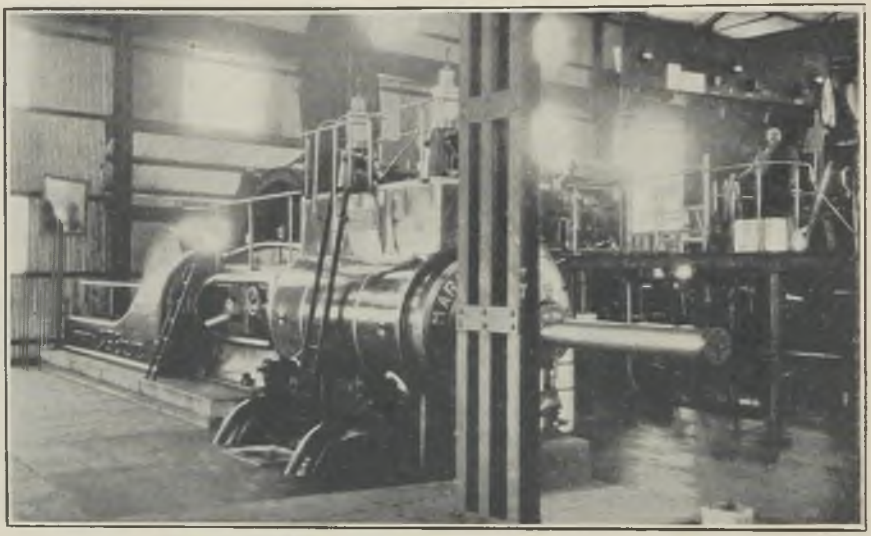


FIG. 9.—MARKHAM HOIST, 7,500 H.P., AT NO. 2 NORTH SHAFT.

(*c*) *Compressor Plant.*—One Fraser & Chalmers' Turbo-Compressor is installed at the Central Power Station, capable of compressing 30,000 cu. ft. of free air per minute to a gauge pressure of 95 lb. per square inch, and preparations are being made for the installation of a 45,000 cu. ft. Brown Boveri turbo-compressor. Other compressors with an aggregate capacity of 27,000 cu. ft. of free air per minute are erected at various points on the property.

The air compressed during the year 1930

amounted to 14,435,314,000 cu. ft. at a cost of 0·472 pence per 1,000 cu. ft.

(*d*) *Operating Costs.*—During the year 1930 the power station generated 155,624,900 units at a cost of ·205 pence per k.w. hour; the sub-station meters registered 140,722,577 units at an average cost of 0·239 pence per k.w. hour or £6 10s. 3d. per h.p. per year.

Hoisting.—The cost of hoisting, which as previously indicated was 2·36 shillings per ton milled when hoisting from a depth averaging 2,300 ft., has since the reorganization been reduced to approximately 1·35 shillings per ton milled for rock hoisted from a depth of over 4,000 ft.

Hoisting is partly by means of steam-driven and electrically-driven hoists, and, in view of the similarity of the different hoisting equipments at the North and South vertical shafts, it is only proposed to describe that provided at the South vertical shaft.

The man hoist is a steam-driven 7,500 h.p. unit, and has a speed of 3,000 ft. per minute. The drums are cylindrical, 14 ft. in diameter and 5 ft. 6 in. between flanges, and the ropes are Langs lay, 2 in. in diameter and 5,500 ft. long with a breaking load of 192 tons. The hoist is fitted with a brake and clutch interlocking device and Whitmore overwind device. A hoist at the No. 2 North Shaft is shown in Fig. 9.

The cages, which are fitted with 15-ton Humble hooks, are double-decked and can accommodate 90 persons; most of the normal underground material requirements can be carried by trucks inside the cage.

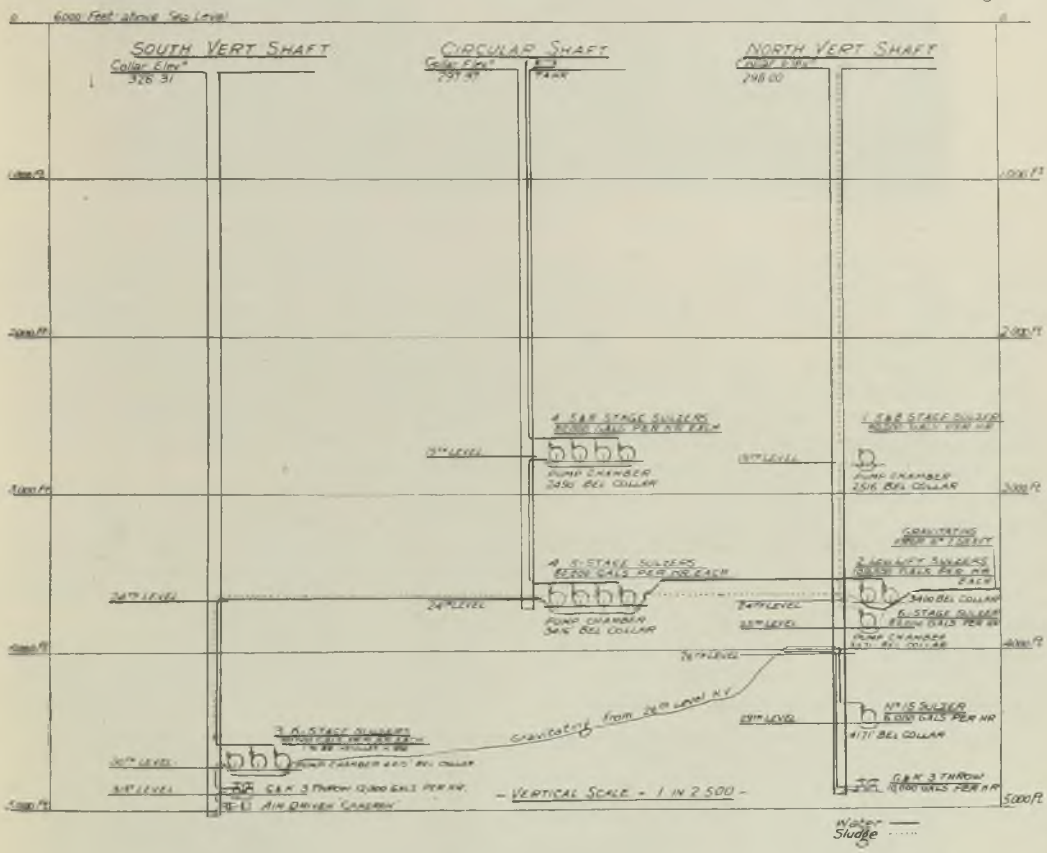


Fig. 10.—Pumping Diagram.

The rock hoist is electrically driven by the Ward-Leonard System. The motor generator set consists of an induction motor of 5,000 b.h.p. (maximum intermittent rating 10,400 b.h.p.), which drives two d.c. generators and exciters each rated at 2,000 k.w. (maximum 3,575 k.w.). A phase advancer set has been installed and the power factor is 0·93 leading.

The hoisting speed is 4,000 ft. per minute. The drums are cylindrical, 12 ft. in diameter, and 6 ft. between flanges. The ropes are of Langs lay, $1\frac{3}{4}$ in. in diameter with a breaking load of 151 tons. The ropes for both man

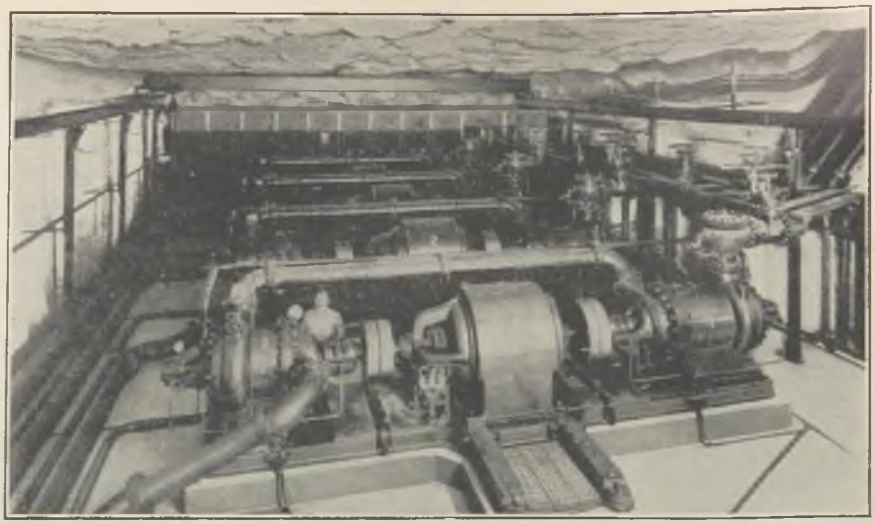


FIG. 11.—PUMP STATION: 19 LEVEL. CAPACITY 8,000,000 GALS./24 HOURS, 2,600 FT. HEAD.

and rock hoists are made at the local factory. Overwind and other safety devices are fitted to the hoist. The skip capacity is 6 tons of rock.

PUMPING.—Prior to 1918 the pumping plant consisted of 93 units erected in 33 separate stations, and, as already stated, the cost of pumping was 2·15 shillings per ton milled; the cost at present—when pumping is from a greater depth—is ·873 of a shilling per ton milled.

The pumping plant has now been concentrated to 3 shafts and the main pumping is done through the South vertical shaft and the Circular shaft in stages as shown on diagram (Fig. 10). Before pumping the water is settled in sumps provided with lip launders, ensuring clean water for the pumps, and the acidity is reduced to 0·002% by the addition of lime. Approximately 4,000,000 gallons of water are pumped per 24 hours by means of direct-coupled Sulzer pumps, the number of stages and power being dependent on the head; the standard capacity of each pump is 80,000 gallons per hour. A pump station at the 19 level is shown in Fig. 11.

The settled sludge is pumped to the surface at intervals by means of one of the centrifugal pumps, the internal fittings of which are made up of partly worn fittings from the other pumps, so as to provide the larger clearances required for handling sludge.

VENTILATION.—The Circular Ventilation Shaft is 22 ft. in diameter and concrete lined. It may be of interest to record that

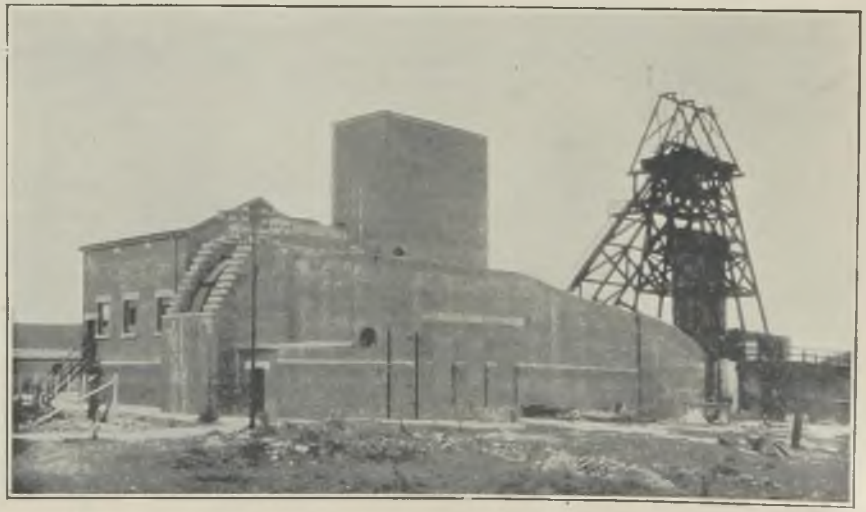


FIG. 12.—VENTILATION SHAFT. CAPACITY OF FAN 600,000 CU. FT./MINUTE: 10 in. W.G.

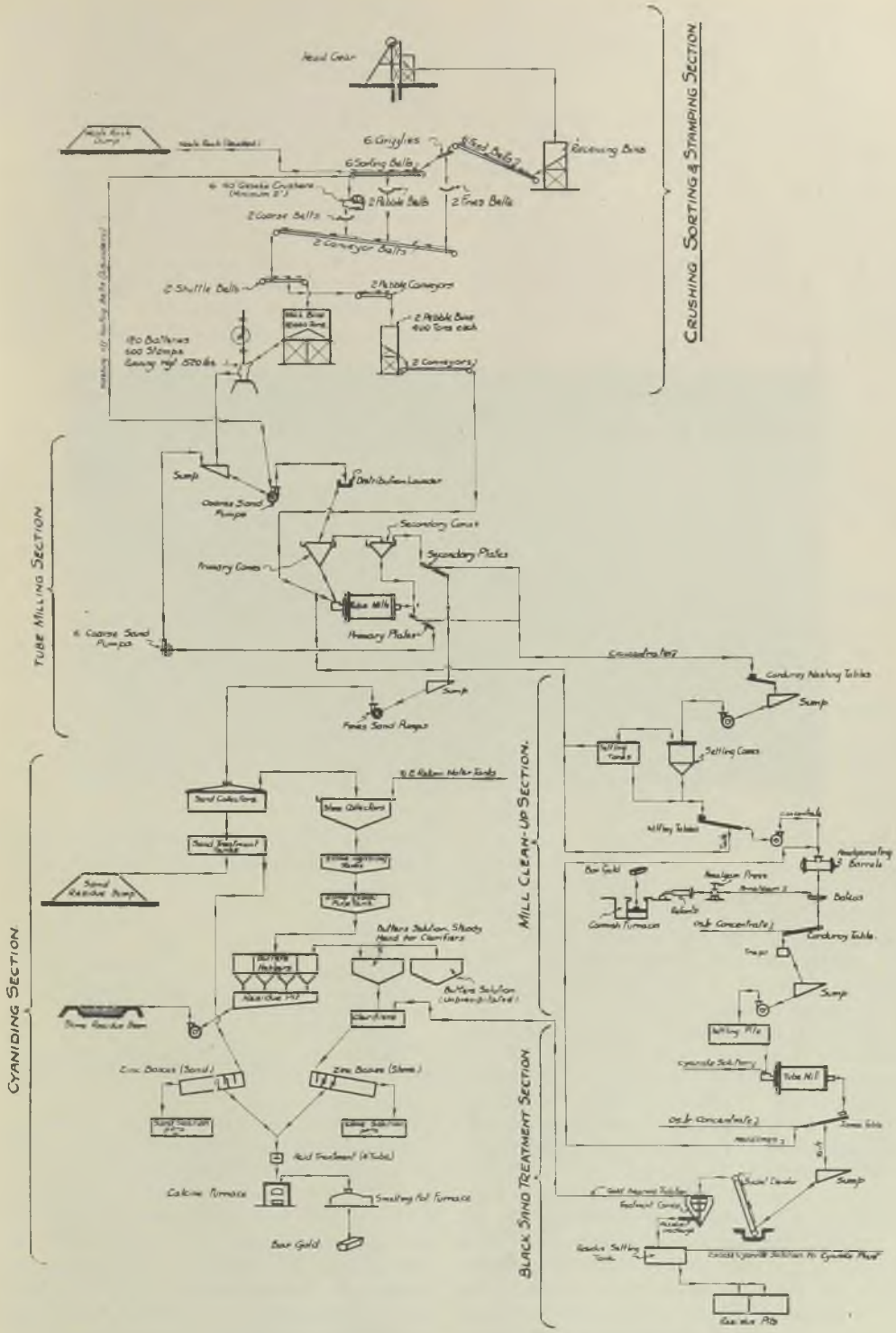


FIG. 13.—FLOW PLAN OF REDUCTION WORKS. CAPACITY 220,000 TONS/MONTH.

this shaft was sunk to the depth of 3,421 ft. and the shaft completely equipped in twenty-two months. In one particular month 386 ft. were sunk from a depth of 986 ft. to a depth of 1,372 ft.

This shaft is connected to the 19th and 24th levels of the North and South Vertical shafts and is equipped with a Walker Indestructible fan, 26 ft. in diameter and 8 ft. wide, which is delivering 750,000 cu. ft. of air per minute at a water gauge of 9½ in. The fan is direct coupled to an English Electric Company's 2,000 h.p. asynchronous-synchronous motor. The head-gear at this shaft is shown in Fig. 12.

(*b*) *Stamp-Mill.*—The capacity of the mill bin is 12,660 tons. The mill building is 612 ft. long by 70 ft. wide and contains 120 5-stamp batteries; the dropping weight of each stamp is 1,520 lb., and the stamp duty 12·5 tons per 24 hours (Figs. 14 and 15).

The screen grading % is :—

+ 60	+ 90	+ 200	—200
53·8	10·0	9·0	27·2

(*c*) *Tube-Mills.*—The pulp from the stamp batteries flows to the tube-mill house, in which there are 18 tubes each 22 ft. long by 5 ft. 6 in. in diameter. The tubes are fitted with corrugated liners and the grinding medium is reef pebbles, 24 tons of pebbles being consumed per tube-mill per 24 hours. The grading to and from the tube-mills is as under :—

	+ 60	+ 90	+ 200	— 200
Pulp entering tube mills % . .	73·1	16·8	5·7	4·4
Pulp leaving tube mills % . .	23·2	24·7	18·8	33·3
Final pulp to cyanide works %	2·2	18·6	23·1	56·1

There are eighteen primary classifiers, each 9 ft. by 6 ft., and eighteen secondary, 5 ft. by 5 ft. 3 in.

(*d*) *Table House.*—The pulp, when sufficiently comminuted to overflow the classifiers, is passed over 176 corduroy tables, each 6 ft. by 5 ft. and carrying three corduroy cloths; the top cloths are changed every two hours and the two lower cloths every four hours. The product from the corduroy cloths is concentrated by three Wilfley tables, amalgamated in barrels, the amalgam then being retorted and the gold smelted.

The average theoretical extraction in the Table House is 55% of the gold content of

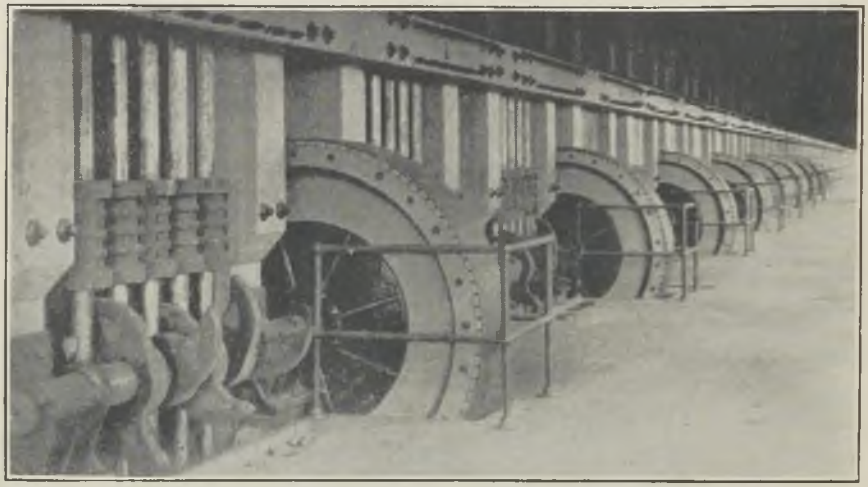


Fig. 14.—600 Stamp Mill : Cam Floor. Length 612 ft.

Surface Transport.—The mine is equipped with 21 miles of private railway line of standard gauge, which is used for delivering material from the workshops to the shafts and the conveyance of ore from the shafts to the crusher station. The private railroad is linked up with the Government railway system.

The ore trains consist of eight 45-ton side-discharge hoppers, and the cost of ore transport is 0·304 of a shilling per ton milled.

Reduction Works.—The nominal capacity of the reduction works is 220,000 tons per month. The run of ore is illustrated in the flow-sheet (Fig. 13).

(*a*) *Crushers.*—From the collecting bins, which have a capacity of 750 tons, the ore is passed, by means of conveyors, over sorting belts, to 40 in. Gieseke crushers which are set to crush to 2 in. cubes. The ore is elevated to the stamp mill receiving bins by two inclined conveyors which have a conveying capacity of 9,000 tons per 24 hours.

the ore ; 400 oz. of osmiridium are collected here per annum.

(*e*) *Black Sands Plant.*—Ninety tons of black sands are obtained per month from the corduroy tables. These are treated in this plant by regrinding and cyaniding.

(*f*) *Cyanide Plant.*—The final pulp from the tube-mill section consists of 48% sand and 52% slime and is pumped to sand collectors with peripheral inflow. The sand settles and the slime and water overflow through a penstock in the centre of the tank and is passed to the Slime Section.

The sand is transferred to treatment tanks and given a cyanide treatment.

The average sand grading % is :—

+ 60	+ 90	+ 200	— 200
5·1	35·4	34·6	24·9

The treated sand is discharged and taken to the dump by endless rope haulage. The slime is dealt with by agitation and a Butters filter plant and thence discharged to slime dam by pumps.

Average slime grading is :—

+ 90	+ 200	— 200
1·8	8·9	89·3

(*g*) *Extractor House.*—The gold-bearing solution from the sand and slime treatment sections is precipitated by zinc shavings in extractor boxes. The extractor boxes are cleaned up twice per month. The zinc-gold slime from the extractor boxes is treated with bisulphate of soda, which is a by-product of the South African Explosives Factory ; the gold slime remaining is washed, pressed in Johnson presses, calcined, and smelted.

The treatment costs per ton milled for the year 1930 were as follows :—

	Shillings.
Sorting and Crushing	0·129
Milling	0·545
Tube Milling	0·485
Cyaniding	0·370
Transferring and Discharging	0·399
	1·928

The total extraction is 95·4% of the gold content of the ore.

During the year 1930 the company milled 2,573,000 tons, yielding 652,607 oz. of fine gold, valued at £2,772,097.

EMPLOYEES.—The average numbers of men employed by the company during the year 1930 were :—

	Europeans.	*Natives.*
Surface	811	3,681
Underground	823	14,699
	1,634	18,380
Wages paid	£639,873	£592,218

In addition to the wages earned, the native employees are housed, fed, and given free hospital treatment. These items cost as follows :—

	£
Housing and administration	67,003
Food and feeding	104 262
Hospital expenses	19,667
Total	£190,932

Housing for Natives.—Owing to the extent of the property, there are five compounds for the housing of native employees and a native location consisting of 146 huts for married native employees and their families. A native hospital consisting of 400 beds is in commission and under the charge of a senior and two assistant medical officers. Dressing stations for the treatment of minor injuries are situated at the compounds. One of the compounds is shown in Fig. 16.

STORES.—The expenditure on stores during the year 1930 was £1,214,257. The main items are summarized below :—

	South African.	*Imported.*
	£	£
768 tons Candles and Carbide	23,332	—
92,481 bags of Cement and Lime	22,470	—
240,945 tons Coal	147,967	—
85,006 cases Explosives	152,320	—
Fuse and Detonators	—	46,227
Native Foods	96,266	719
140,300 gallons Oil	—	12,428
Pipes and Pipe Fittings	15,879	46,381
Rails and Fittings	15,828	8,004
Rock Drill Spares and Hoses	13,578	64,529
Wire Rope	11,334	1,602
688 tons Shoes and Dies	8,429	—
646 tons Drill Steel	—	28,954
550 tons Other Steel	—	9,117
30,475 tons Mining Poles and Laggings	80,292	—
Deals, Pitch Pine, etc.	163	53,770
Tube Mill Liners and Spares	13,205	533
Trucks and Spares	2,044	7,931
468 tons Cyanamid	—	16,057
234 tons Zinc	—	7,870
Machinery	9,496	62,436
Machinery Spares	6,451	24,061

MINERS' PHTHISIS ACT.—This company's proportion of the outstanding liabilities of the Miners' Phthisis Compensation Fund, payable in terms of the Miners' Phthisis Acts Consolidation Act, 1925, in the event of the mine being closed down, was, at July 31, 1930, assessed at £579,887. To meet this liability a sum of £29,805 per annum has to be set aside from the profits.

In addition, during 1930 an amount of £48,533 was included in the working costs for current compensation in terms of the Act.

FIG. 15.—600 STAMP MILL : MORTAR BOX FLOOR.

WORKING EXPENDITURE.—

	Shillings.
Mining	9·939
Developing	2·288
Hoisting	1·352
Pumping	·873
Transport of Ore	·304
Ore Sorting and Crushing	·129
Milling	·545
Tube Milling	·485
Cyaniding Sand and Slime	·769
General Expenses—Mine	·977
Miners' Phthisis Contributions	·449
	18·110
General Expenses, Head Office and London	·216
Gold Realization Charges	·079
	18·405

ANALYSIS OF WORKING COSTS PER TON CRUSHED.—

	Shillings.	*Per Cent.*
European Wages	4·424	24·04
Native Wages	4·375	23·77
Stores	7·691	41·79
Sundry Expenditure	1·915	10·40
	18·405	100·00

RESIDENTIAL QUARTERS.—There are 373 married quarters for Europeans on the property let at an average rental of £3 10s. per month. The rental includes the cost of light, water, and sanitation. Rooms are also provided for the single employees at a rental of 10s. per month.

RECREATION CLUBS.—For the convenience of the European employees of the company three recreation clubs are established on the property. These clubs contain a reading room, billiard room, card room, and library, and a dancing and concert hall is in use for social functions, meetings, etc.

SPORTS GROUNDS.—For the outdoor recreation of the European employees and their families there are tennis courts, bowling greens, a nine-hole golf course, and cricket and football grounds, and two large swimming and boating enclosures.

The native employees have cricket and football grounds and a weekly cinema show.

I have pleasure in thanking the various members of the engineering staff of the Johannesburg Consolidated Investment Company for their ready help in preparing this article and particularly Mr. K. Richardson, assistant consulting engineer.

FIG. 16.—SOUTH COMPOUND : 5,631 NATIVES.

THE GOLD REEFS AT REMANCE MINE, PANAMA

By A. IGNATIEFF, A.R.S.M., B.Sc.

The author outlines the geology of a mine which is rapidly approaching the production stage.

The Remance mine is situated in the southern foothills of the main Cordillera chain of mountains, known in the North American continent as the Rockies and in the South American as the Andes. The highest peak of this range in Panama, the Volcan de Chiriqui, lying to the west of Remance, is about 11,000 ft. above sea level, but in the neighbourhood of the mine the highest altitude of the Cordillera is about 4,000 ft. The southern slopes of the main range are the more undulatory, while the northern slopes are the more precipitous; said to outcrop on the southern slopes of the range, 15 to 20 miles in an air line from Remance. There are several varieties of andesite occurring on the mine, but, megascopically, two forms may be broadly distinguished, a hard aphanitic, or stony, andesite, and a soft, more porphyritic, rock. It is very probable that these varieties date from different periods of intrusion, the soft rock being, however, the more recent. The old andesite appears to be less rich in ferro-magnesian minerals than the later rock. The stony andesite is

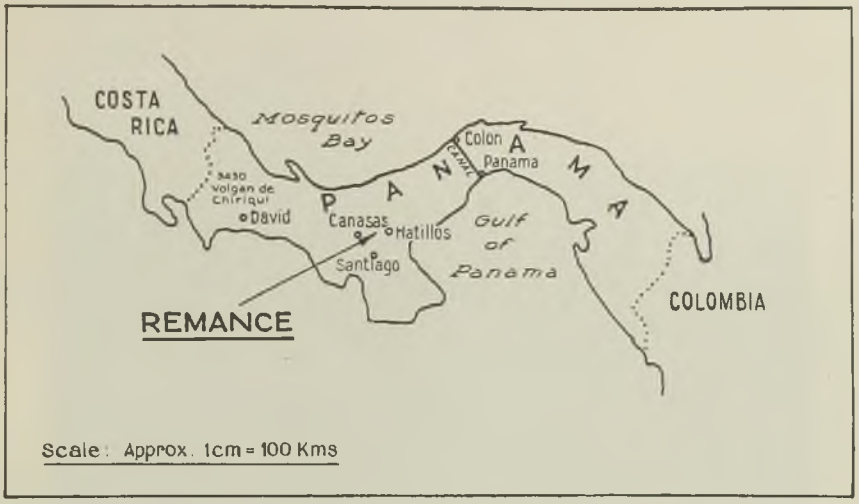


FIG. 1.—SKETCH MAP OF PANAMA REPUBLIC, SHOWING APPROXIMATE POSITION OF THE REMANCE MINE.

the foothills are followed by plateaux and plains to the Pacific and Atlantic oceans (Fig. 1).

Throughout the plains are scattered rhyolitic and dioritic hills and mounds and there is abundant evidence of recent volcanic activity. The main range gradually descends towards the east, in the canal zone the highest altitude being about 300 ft. The average elevation at Remance is about 750 ft. and the ground slopes southwards to an altitude of 300 ft. in about four miles; northwards the ground rises to the Cordillera range. Wide valleys traverse this part of the country, which appears to have undergone considerable erosion.

The country around Remance is essentially igneous-basic, the rock being an andesite—a rock which is so typical of the Cordillera. Acid rocks of comparatively recent date are best developed in the centre of the property and disappears northwards under the porphyritic andesite which forms the hill of Cerro Esquinado (Fig. 2). This andesite is doubtless the most recent rock on the property. In the southern end of the area, several varieties of andesite outcrop which show both flow and porphyritic structure.

VEIN SYSTEM.—The Remance vein system is apparently a group of true fissures, of which the most important is the main Remance reef. Its outcrop is marked by its regularity along a magnetic north-south strike and has been traced for over 8,000 ft. It forms the backbone of Remance Hill (Fig. 3), and outcrops prominently on Powder House and South Hills and on the ridge connecting the two hills. The southern extension of the reef has not been traced past South Hill, from which the ground

slopes abruptly to the plains (Fig. 4). Its northern extension disappears under the recent andesite capping of Cerro Esquinado. The width of this reef is variable, but averages about 5 ft. The dip is steep either eastward or westward—the change in direction of dip between short horizon intervals being very noticeable.

The other veins are apparently branches of, or at least related to, the main reef and may be divided into two groups; (1) The northern veins, which diverge to the south-west from the general strike of the main reef in the neighbourhood of Los Torros creek, and (2), the southern group, diverging to the north-east from the strike of the reef at the source of the Mill creek. The divergence of the latter, however, is not so apparent, the chief reef of this group (Rosa I) being more parallel to the Main reef. The outcrops of these veins are not as clearly defined as that of the Main reef and their intersections with it have not been definitely established up to the present.

Of these two groups, the northern appears to be the more important and the better known. There are four veins, the Guatia, Guarumo, Guarumito, and Baltazar, and of these the first is the chief vein. Its outcrop has been traced for about 3,600 ft., but its northern and south-western extensions are not well defined on the surface. At its northernmost point, where it should join the Remance reef, it is apparently covered by the recent andesite capping, which has hidden the main reef in a similar way, as is clearly seen in the tunnel at the 676 ft. level, on the north side of the Torros creek. Here the outcrop of the main reef is covered by andesite for about 200 yd. It is revealed again for a short distance in the Torros creek further north, to be lost entirely under the main capping of Cerro Esquinado. There have recently been indications in depth, however—at the 570 ft. level—of the existence of such an intersection. In the southern extension, the Guatia reef is divided into three branches, which are lost in the spur hillocks sloping westward towards the plains.

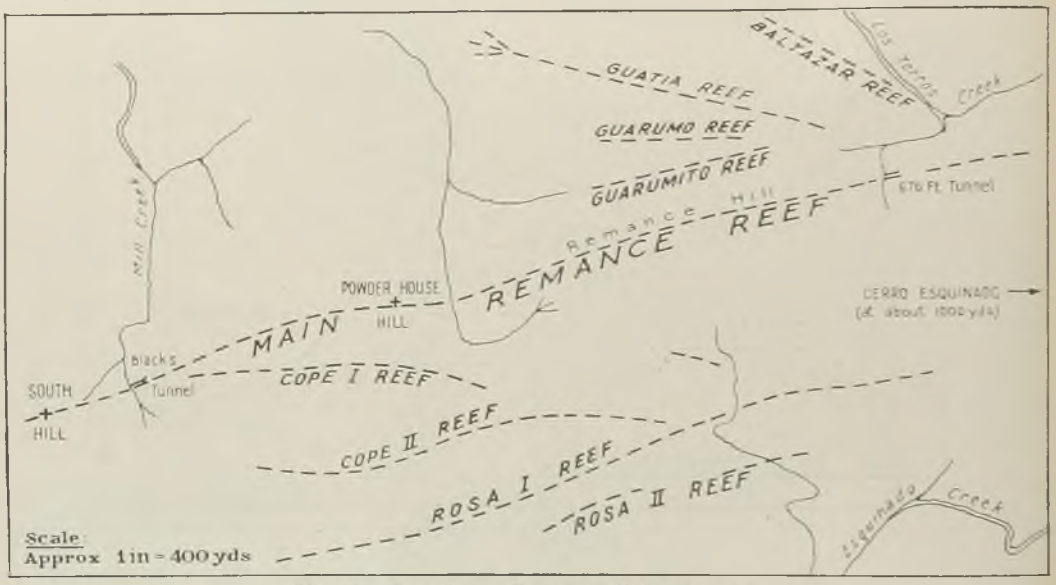


Fig. 2. Sketch of Remance Reef-system.

The southern group consists of the reefs, Rosa I and II, and Cope I and II. The outcrop of Rosa I has been traced for 6,240 ft., its northern extension, as in the case of the main reef, disappearing under the andesite capping of Cerro Esquinado. The junction of Cope I reef with the Main reef at its southern end has not been proved at shallow depth by a tunnel driven north in the Main reef in the Mill creek.

In addition to these reefs, there are an innumerable number of short veinlets and pockets of quartz, the latter usually occurring in the more recent andesite. These short veins appear to strike to the same converging point as the longer reefs and this is particularly noticeable in the southern lateral group.

Character of the Veins.—The reefs have every appearance of hydato-genetic origin, mainly evidenced by the banding of the quartz, which occurs usually in a massive or crypto-crystalline form. Often the quartz is tarnished by iron and manganese oxide and this variety sometimes carries high values. Tourmalinized quartz is met with, generally in passages through stony andesite and in such occurrences the quartz has a truly crystalline structure.

The reef gangue is composed of quartz, pyrite, and, very rarely, calcite. The reefs are not clean, often containing partings of country rock. This is particularly common in their passage through the recent andesite. These partings, and both walls, are often impregnated with gold and it is interesting to note the widespread, though slight, mineralization of the porphyritic andesite, which, being more rich in ferro-magnesian minerals, is more conducive to decomposition by solutions carrying gold. Alteration of the andesite is more developed in the porphyritic rock, the alteration continuing for considerable distances from the true reef. The walls generally reveal propylitization, but high values are not generally found in the gouge. Alteration of the stony andesite is less pronounced, the fissure in such rock being narrower, although an increase in value does not generally occur. The joints of the country rock strike in the same direction as the fissures, the former being particularly well developed in the harder, stony, andesite, where the splitting up of the reef into well-defined branches is often observed.

At intervals along its strike the reef is brecciated, limonite or hæmatite being the cement, and in passages through harder andesite the walls show slickensides.

Two types of ore occurring at Remance may be broadly distinguished, a blocky, hard and clean quartz ore, generally found at the southern end of the main reef in the upper levels and a friable ore, greatly mixed with andesite, from the northern end of the property in levels which are correspondingly lower in elevation. In the first type the gold is found to be coarse, but in the second variety it is in a much finer state. Microscopical examination of the gold from the latter ore shows it to be finely intergrown with pyrite and rather dark in colour. The panning of samples of the ore sometimes does not agree with the assay results and it is probable that some of the gold is present in a combined form. The silver content of Remance ore is nearly negligible and the gold is noted for the absence of injurious metals.

Mineralization of the fissures is of an inconsistent nature. High values cannot as a rule be traced for long distances; they oscillate within the reef and often can be picked up in the country on one of the walls; nor are they confined to the quartz—indeed the andesite partings are often richer than the surrounding quartz. This feature is

Fig. 3.—Main Reef Outcrop on Remance Hill, with Cerro Esquinado in the Background.

encountered in exploration along the strike or plane of the dip of the reef and probably indicates an interruption of solution channels through movement, which may have been contemporaneous with, or later than, the mineralization period, and appears to have been more directional than lateral. Apart from local deviation in strike and plane of dip the reefs are very regular and only in few instances has a small lateral displacement been observed.

The direction of ore-shoots is also somewhat difficult to trace for great lengths or depths, probably for the same reasons, but there seems to be a tendency for them to pitch northwards, at least in the case of the upper levels; this may be partly due to the trend of natural drainage. Some secondary concentration by oxidation and reduction of volume of ore has probably taken place through this agency, the friable rich ore in the upper levels near Torros creek being, no doubt, due to this process.

SUMMARY.—The Remance reefs appear to form part of a vein system resulting from compressive movement—a type of shear zone. It is noteworthy that the main branch systems diverge from the Main reef in the two lateral valleys (Los Torros and Mill); these valleys may represent lines of weakness resulting from the original movement. The filling of the veins of these two groups may have been contemporaneous with, or later than, that of the Main reef.

The mineralizing solutions may owe their origin to the emanations from the acidic rocks of the Cordillera, or may be the products of hydro-thermal processes accompanying one of the intrusions of andesite porphyry.

The mineralization is believed by most geologists to be Tertiary, a period which was marked in this part of the world by general and local earth movement and volcanic activity. The andesite of Cerro Esquinado and the region further north, as well as the numerous lava outliers in the plains and plateaux probably date to post-Tertiary times. Since that epoch the country has been undergoing depression and consequent erosion, the plains on the north and south of the main Cordillera range being covered by vast tracts of alluvial ground.

FIG. 4.—SOUTH HILL, REMANCE MINE.

The Remance reefs are not the only mineralized veins in this region. There are numerous veins that have been found in the Cañazas district to the west and Hatillos to the east; these, however, contain lead, zinc and copper, in addition to gold and silver, but they are also adjudged to be of the same age as the Remance reefs. The Cordilleras themselves have been only cursorily prospected, but there are numerous reports of the existence of both barren and mineralized quartz reefs. These deposits appear to be related to the series of hydro-thermal veins occurring in Costa Rica and the northern Central American countries.

NOTES ON PRACTICE

Filtering Lead and Zinc Concentrates.—The concentrates resulting from the flotation of a lead-zinc sulphide ore by the Ergasteria Flotation Company, at Laurium, Greece, are filtered direct without previous thickening. The finished concentrates as they come from the Minerals Separation machines are 60% to 62% solids and the launders for the froths are constructed with a minimum slope of 3¼ in. per foot to avoid using launder water.

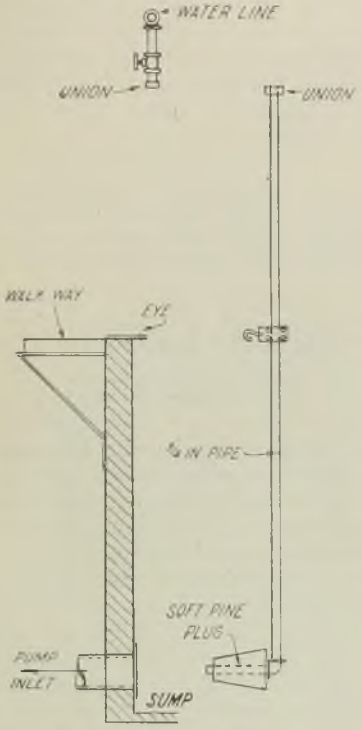


FIG. 1. FIG. 2.

The concentrates run to concrete sumps, from which they are delivered a distance of 75 ft. horizontally and against a static head of 20 ft. by a Wilfley pump into the bottom of the filter pans through manifolds. The filter is an 8-ft. 6-disc United machine, two discs being used for lead and four for zinc concentrate.

The concentrate sumps are each large enough to hold the normal pump head as well as the respective filter compartment contents, so that the filter can be drained back to the sumps at a shutdown. It was found that during such suspensions of operation the concentrates settled both in the pump and in the delivery lines to such an extent that re-starting was attended by much loss of time and material. To overcome this difficulty and as there was insufficient room to install auxiliary boxes between the main sumps and the pumps, Mr. Ernest Maurer, the master mechanic, designed a very simple and effective arrangement, sketch of which is given.

Fig. 1 shows the outer wall of the sump with outlet to the pump. A solid "eye" of ⅝ in. round iron is bolted securely to the top of the wall directly above the pump outlet. A ¾-in. water line is installed over the sumps about 3 in. inside the line of the wall. A tee-valve, and one end of a union are in line with the eye and the outlet to the pump.

Fig. 2 shows a ¾-in. pipe with the other end of the union at the top, a clamp with a swing hook in the proper position to engage the eye when the connexion is made to the water line, an elbow and nipple at the bottom. Over this nipple is fitted a soft pinewood plug, with long taper to fit into the outlet to the pump.

When shutting down the pipe and plug are lowered into the sump, the hook and eye engaged, and the plug forced into the outlet. The pipe is then connected to the water line and the valve opened. The bye-pass valve near the filter pan is opened, allowing the filter contents to discharge through a launder back to the sump, the Wilfley pump running with water to clear itself and the discharge line.

In re-starting the water valve is opened and pump run to make sure that the line is clean; filter pan bye-pass closed; pipe disconnected and removed. If the concentrate has settled so heavily around the plug that the latter cannot be withdrawn it is loosened with a long ½-in. pipe-nozzle attached to a hose from the water line.

C. Q. SCHLERETH.

☛ Engineers are invited to send practical suggestions for insertion under this heading.

BOOK REVIEWS

The Study of Crystals. A general introduction. By T. V. BARKER. Cloth, octavo, 137 pages, illustrated. Price 8s. 6d. London: Thomas Murby and Co.

This is not a treatise on crystallography following conventional lines. The geometrical aspect of the subject, which is so

adequately dealt with in numerous standard text-books, has been largely subordinated to considerations of crystal growth and to simple experiments by which that growth may be observed and studied. The book, indeed, is addressed not so much to the professed crystallographer as to the chemist, the physicist, and the mineralogist, to most of whom the constitution and genesis of crystals now make greater appeal than the phenomena merely of external form and symmetry. The method of approach being essentially experimental the crystals referred to are more often those of salts prepared in the laboratory than of natural minerals; but, wherever fundamental principles are particularly well exemplified among common minerals, illustrations from the mineral world are given due prominence. In this way, while the primary endeavour "to awaken interest in a branch of study which has been too long divorced from the routine teaching of chemistry and physics" has been achieved, the interest of those with a mineralogical bias has also been maintained. In selecting his experiments the author has been at pains to employ, as far as possible, those involving small expense, thus making the book acceptable where simple equipment alone is available.

The subject-matter has been presented in six parts, "arranged in natural sequence," viz. crystal growth; geometrical properties; cleavage and structure; physical properties; polymorphism, isomorphism and enantiomorphism; and equilibria between liquid and crystal phases; and, within the limitations of apparatus prescribed, each of these has been illustrated by a series of appropriate laboratory exercises. The volume is moderate in size and reasonable in price. Its subject has been presented in the clear and attractive style characteristic of all the author's writings. It should constitute a valuable addition to the more formal treatises on crystals, especially if used as a guide to laboratory work conducted along somewhat novel lines. Dr. Barker is admirably qualified to produce such a work, having been connected with the teaching of mineralogy and chemical crystallography at Oxford for nearly twenty-five years. In addition to the scientific duties he there performs, he acts also as Secretary to the University Chest and as a Curator of the Bodleian Library.

C. GILBERT CULLIS.

French-English and English-French Dictionary of Commercial and Financial Terms, Phrases, and Practice. By J. O. KETTRIDGE. Cloth, large octavo, 647 pages. Price 25s. London: George Routledge & Sons, Limited.

This useful dictionary is an enlargement of the "Dictionary of Financial & Business Terms, Phrases & Practice" by the same author, of which two successful editions have appeared. The whole of that dictionary has been revised, recast, and brought to date, and a number of new subjects have been added. On studying the publication it is surprising to find how comprehensive the work is and it cannot fail to prove of great assistance to the commercial and financial world.

MURRAY STUART.

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

NEWS LETTERS

JOHANNESBURG

February 5.

Gold Discoveries in the Orange Free State.—Rand mining houses have secured options over many farms in the Rouxville district, Orange Free State, where pieces of gold-bearing rock have been found. Some of these pieces of rock have been assayed by the Mines Department and one yielded over 7 oz. to the ton. According to a report made by Professor Paul Kovaloff, of Johannesburg, a dolerite sheet of unknown thickness has penetrated a wide extent of country in that neighbourhood, as is so often the case in the Karroo areas and is overlain by black shales passing into sandy shales, and by sandstones. Adjacent to the dolerite is a zone of contact alteration of the sediments, from 2 to 2½ ft. in thickness, in certain parts of which gold is present. The shales are altered into a hard compact rock of greenish or buff colour, which, further from the contact, gradually passes into the normal shale. The conclusions, as stated by Professor Kovaloff, are: (1) There is no reason to doubt that the presence of gold has been shown in some samples sent from the Rouxville district to Johannesburg for analysis in the Government Laboratory, some of the results being highly

encouraging. (2) The samples analysed were taken from the zone of contact alteration of the sediments. (3) The distribution of gold in this zone of contact alteration seems to be very erratic ; some samples show high values, and some, taken from the same place, do not even give traces on panning. It is quite conceivable, it is explained in this connexion, that the distribution of gold across the contact zone is not uniform, and is limited to a certain thickness of the altered rock—perhaps to the immediate contact with the dolorite. A discrepancy in the results of the tests of the rock taken from the same spot does not necessarily imply, therefore, an erratic distribution of the gold values in the direction of the strike. To come to a definite conclusion on this point, it is added, requires an opening up and systematic sampling of the occurrences. The fact that such a discrepancy exists, however, calls for great caution in the matter. Prospecting operations are proceeding on some of the farms and since Professor Kovaloff's visit a conglomerate reef has been exposed in a trench. At the time of writing it is not known whether the reef carries gold.

The Foot-wall Reef of the Far East Rand.—In a paper read before the Geological Society of South Africa Mr. E. H. A. Joseph, Deputy Inspector of Mines, Brakpan district, gives some interesting information regarding the foot-wall reef of the Far East Rand. This has recently attracted much attention in connexion with developments in the New Kleinfontein mine. According to Mr. Joseph the reef in question—known in the New Kleinfontein as the Vertical Reef—has been worked for 25 years. At first it was supposed that the work in the New Kleinfontein was on a faulted portion of the Main Reef Leader, and it is only in the last few months that the foot-wall reef has been definitely recognized as being quite distinct. Since then a large amount of careful correlating and prospecting has resulted in the tracing of the same formation at all the intermediate levels. The foot-wall reef has been identified in the following mines :—New Kleinfontein (including the Apex section), Van Ryn Deep, Witpoort Gold Areas, Brakpan Mines, New Modderfontein, Government Gold Mining Areas, and Geduld Proprietary. The western edge, or sub-outcrop, has been located at a large number of points, but the eastern limit has not yet been determined. At present the ascertained width of the trough is something over 800 ft. The greatest depth of this reef below the Main Reef Leader appears to be about 60 ft. Mr. Joseph thinks it is probable that a systematic inspection of all exposures of foot-wall country in the mines of the Far East Rand would not only disclose the continuations of the synclines already located, but also other distinct occurrences of potential economic value. The foot-wall reef has been definitely correlated with the West Reef of the Witpoort Gold Areas, where it is understood to have given some encouraging values.

The Kimberley Series.—Towards the end of 1930 several reefs belonging to the Kimberley Series were intersected in the shaft which the Daggafontein Mines, Ltd., is sinking on its lease area, but in no case did sampling disclose payable values. In January of this year, however, at a depth of 2,264 ft., a reef was encountered of which the sampling returns of ten sections averaged 10 dwt. over a width of 51 in., or if one sample, which was far above the others, is excluded, 7·34 dwt. over 50 in. for the remaining nine sections. Despite these satisfactory results the record of the Kimberley reefs in the district in which the mine is situated is such that, in the opinion of the consulting engineers, importance cannot be held to attach to this disclosure pending further exploratory work. To undertake such work now would delay the completion of the shaft, and therefore the start of production, so that the investigation of this reef must therefore be deferred.

BRISBANE

January 21, 1931.

Water Difficulty at Mount Isa.—On the authority of the district Inspector of Mines (Mr. F. Young), it is stated that the water difficulty at the Mount Isa mines is not so gloomy as it has been. Davidson's shaft, on the Black Star lode, he says, is dry, and the man and supply plat is also clear of water. Here pumps will shortly be at work again and these should be able to keep the water well in hand. The ore-pocket in the main haulage shaft has been sunk 112 ft., and sinking has been resumed in the shaft. The 1A winze in Doherty's, on the Black Star lode, has been sunk to a vertical depth of 214 ft., and the south drive from the main haulage shaft holed through to it at this point in 425 ft. of driving.

When production starts the ore from the Black Rock lode will be transferred to this winze ; thence along the level to the ore-pocket at the bottom of the main haulage shaft and then to the surface. The electric hoists are complete, and ready for a trial run.

Approaching Production.—The Cloncurry warden (Mr. S. Wilson), in his report on progress at the Mount Isa mines dated January 7, says the whole of the mining system and treatment plant should be in operation as soon as connexion is made by means of the main haulage level between the supply shaft and the Urquhart shaft, as well as between the Doherty shaft, on the Black Rock lode, and the Lawlor shaft, on the Rio Grande. These connexions should be finished by the end of March. The west drive, from the Urquhart shaft to the supply shaft has been driven 819 ft., and there is less than 800 ft. of further driving to be done to connect the two shafts. The south drive from this haulage level to the Black Rock lode during December holed through at 425 ft. to No. 1A winze in the Black Rock lode. The drive has been completed for a further 125 ft. past the winze towards the Rio Grande lode. There is still about 1,500 ft. of driving to be done to connect the two lodes. This driving is now being carried out from both ends. In the Black Rock lode carbonate ore above the No. 3 level has been completely developed, and is ready for stoping ; while preparations for stoping carbonate ore above the No. 1 level in the Rio Grande are now in progress. The blocking out of sulphide ore on this lode is proceeding from No. 3 level and from the haulage level. The whole of the surface plant is now nearing completion. The crushing plant is finished except for some riveting work in the crude-ore bins. The concentrating mill is finished except for a few details. The construction work on the smelter is well advanced, the only building not in the last stages being the Cottrell plant, where the brickwork is still to be done. The plant at the power-house (consisting of 2,500 k.w. turbo alternators, with Babcock and Wilcox units) is now in operation. The community building programme likewise has been finished, and the company now provides housing for 852 employees.

Mount Morgan Ore.—The new Mount Morgan company, which is working along steady and cautious lines, has just issued its half-yearly report, covering the six months ended December 31 last. In that period the total production from the precipitation plant, which has been kept constantly at work since the company took over the property, was 167½ tons, which was contained in 201 tons of precipitates. At the same time the level of the mine was lowered in the mine 20 ft., representing the dealing with 12,000,000 gallons of liquid from which the metal was leached. It is estimated that the copper leached out of the ore during the six months was equal to 5·16 lb. per 1,000 gallons. This result, for a continuous operation on one small section—that is, without an oxidizing interlude—is considered by the directors as very reassuring for future operations on a larger scale.

Regarding a representative parcel of Mount Morgan copper ores sent for testing purposes to the American Cyanamid Company, of New York, a report has been received on the work done by that company up to the middle of November. This shows that the ore was concentrated with a ratio of 10 or 12 to 1, for a recovery of 90% of copper, and 74% of gold. This, it is explained, points to a probable higher ratio of concentration being obtained without reduction in recovery, and consequently to a higher profit than the 9s. a ton based upon the old practice on a concentration ratio of 3·45 to 1. The directors of the Mount Morgan Company say that, in addition to the enhanced profit, the gold bonus, which is now an accomplished fact, has to be considered, as well as the favourable rate of exchange now operating, and it is estimated that, on the whole, the value of the ore has improved probably by 6s. a ton. The chief value of the accessible ore, estimated at 664,000 tons in quantity, is in its gold content, and Mr. A. A. Boyd, so long identified with the old company and now director and consulting engineer of the new, has previously stated that a bonus on gold production would enhance the exploitation of the ore as a profitable project.

Gold near Rockhampton.—The most important recent gold discovery in Queensland is one reported last month from Mount Cassidy, 45 miles north-west from Rockhampton and 25 miles from the terminus of the Alton Downs branch railway. A government geologist has reported that the lode is not of the ordinary reef type, and that the discovery is one of very great interest. While not likely to be carrying spectacular values, it promises to be big.

even if rather low in grade, and may establish an industry of some permanence. The deposit needs opening up, and the geologist says that to do adequate justice to the prospect capital is needed behind the prospectors for probably six months' prospecting work on a systematic plan.

Coal Shipped from Newcastle.—The serious position of the coal-mining industry of New South Wales is reflected in the returns lately published relating to the shipments of coal from Newcastle. The quantity despatched from that port during the year 1930 was 2,608,000 tons, which is only 500 tons more than for 1929, although the Northern coal mines were idle for six months of last year. It is evident that much of the trade lost during the 15 months' stoppage of the principal mines of New South Wales has not been regained, and thousands of miners formerly engaged in the Newcastle and Maitland districts have irrevocably lost their jobs.

Mineral Outputs in 1930.—The yield of gold in Western Australia for 1930 was 416,369 fine oz., valued at £1,768,623, or 39,193 oz. more than in the preceding year. It is estimated that the output of all minerals for the past twelve months in New South Wales will approximate in value £10,000,000, compared with £12,750,000 for 1929. Coal production in that State is believed to have dropped by 600,000 tons to about 7,000,000 tons. It is also expected that Queensland returns when available will show considerable decline in the production of minerals.

IPOH

February 7.

Tin Restriction.—The mists of doubt as to effect and of uncertainty as to application still obscure major points of the proposed restriction scheme; but it is generally understood that a large majority of producers have signified that they are in favour of some equitable scheme of restriction, and it is also felt that the F.M.S. Government may be relied upon to safeguard the mining interests of these states upon which so large a proportion of the revenue depends directly and indirectly. An announcement is expected within a few days. While looking to the government to secure fair terms and to frame a workable scheme, the mining community have now to secure that their own side of the business is in the best order to meet the requirements and changing tendencies of the present times.

Efficiency.—There is a most valuable field here for British machinery for mining purposes, but it is not properly exploited except in electrical equipment. Any experienced observer looking at examples in stock—especially of pumps—held here by engineers and merchants, must realize that many of them embody features very unsuitable for the services commonly required. This subject has been mentioned in previous letters, but is becoming more and more urgent. At such rates of cost as have long been normal the open-cast miner using power-driven gravel pumps of the usual types on average values is up against a very difficult problem to make ends meet. The difficulties are greater when—as is the case in many well-known mines—the deposit is in the form of a deep and irregular gutter between limestone and the weathered granitic rock of the foothills; and there are also difficulties in the economical cleaning up of values in pockets, fissures and between pinnacles of the limestone which forms so large a proportion of the floor of the Kinta mining field.

The chief lines along which progress may and, indeed, must be made are:—

(1) Consolidation of areas to save waste in the many ways unavoidable when ground is divided up into small and often inconveniently associated portions.

(2) Centralization of control and for supply, distribution, and use of power.

(3) Scrapping of inefficient plant and methods and substitution of such as will better meet the needs of the various conditions.

(4) Direction of operations under suitably trained and technically competent advice and management.

Even comparatively recent installations, such as some dredges on certain types of ground, though still profitable, may be of very low economic efficiency. For example, it is quite well known that bucket dredges cannot recover a high proportion of the total values lying on the usual type of limestone bottom, but the industry is not limited to the use of bucket dredges for this purpose. A well known plant in Kinta exemplifies intelligent and skilful departure from customary methods and employs a pontoon which can be floated from place to place as required, but normally works resting on a sand bottom, carrying upon it the whole equipment of pumps for sand and gravel, and jigs, which can be used at will to strip

overburden or to win the frequent high values in hollows and pockets of the bedrock, all with a minimum of labour. There are large areas in the F.M.S. where plant of this kind would be much more efficient in extraction of tin ore than any bucket dredger and would still be much lower in costs than the usual methods of open-cast mining.

The Chinese owned mines suffer from many of the disadvantages for which remedies are indicated as urgent, but their great obstacle is their management by owners and their friends and former employees—all accustomed only to the crude, but formerly very profitable, methods which served so well when much of this very rich tin field was virgin ground. The same methods of management and of operation will not serve now, but proposals of unknown or untried ways are distrusted by such people. There have been unfortunate examples where modern equipment has been provided, at large capital cost, on deposits which had not been sufficiently tested and have since turned out unprofitable. Cruder methods would have involved much less loss, but the fault was in the lack of sufficient proved ore.

Statistics.—Visible supplies of tin at the end of January are recorded to be 43,200 tons, showing an increase for the month of 900 tons, being only 400 tons less than the record to August 31 last which was 43,600 tons. These figures with the other particulars compiled for the month all go to prove the urgency of effective restriction. Imports of tin ore from foreign sources during January amounted to 4,088 tons. In 1930 total imports were 46,680 tons, averaging 3,890 tons per month.

New Dredge.—On January 25 the Perak section of the Engineering Association of Malaya, the members of the F.M.S. Chamber of Mines, and other invited guests had the advantage of inspecting the new No. 1 Dredge of Lower Perak Tin Dredging Ltd., a few miles south of Tanjong Toh-Allang. The dredge is of large capacity, being expected to treat 350,000 cu. yd. per month under normal conditions. It is of the close-connected bucket-elevator type, designed to dig 100 ft. below its paddock water level. The machinery is electrically driven and the total h.p. of motors installed, namely 1,328, is probably greater than on any other dredge to date. The pontoon is 206 ft. long by 66 ft. beam and 10 ft. deep. The design shows several distinctive features including the control of the winches and digging machinery by pushes on a control board through compressed air operating the clutches and brakes. Sheaves are provided at the lower end of the ladder for the bow lines. This is to reduce the bending moment on the ladder which may be severe when the lines pull on the hull as is usual. The dredge was designed and built under the direction of the Yuba Associated Engineers of San Francisco as consulting engineers for the Anglo Oriental Mining Corporation, Ltd.

Power will be taken on the dredge from the Perak River Hydro-Electric Power Company at 6,600 volts and transformed down to 440 volts for the motors and 110 volts for the lighting system. The buckets are of manganese steel and of $13\frac{1}{2}$ cu. ft. capacity without allowing for side horns which in certain types of ground will increase the capacity. There are 129 in the line, each weighing 3,200 lb. The operation and economic efficiency of this dredge will be watched with interest by the miners and other engineers who have had the privilege of going over it when nearing completion.

TORONTO

February 17.

Sudbury District.—Production at the Frood mine of the International Nickel Company which has for some time been on the basis of about 75,000 tons a month has been advanced to 100,000 tons a month. The output from the Creighton and Garson mines is not being increased, but on the other hand may be lowered. Now that the construction programme has been largely completed the company finds its mines and works in a general condition to produce metal in excess of requirements. In regard to development and exploration the mines already have so much ore exposed that it is no longer necessary to look for more and attention is now being mainly directed towards the reduction of operating costs. Underground work may now be confined to the development necessary to provide an outlet for the ore. The ore now in sight is unofficially estimated at about 200,000,000 tons. The Falconbridge continues to carry on operations on a 300 ton daily basis, the smelter having operated steadily since production was resumed at the first of the year. Smelter capacity, owing to the recent additions to the blast furnace, is around 450 tons per

day, but the present rate will probably not be increased until market conditions have improved and a further supply of power is obtainable. Underground operations have been confined chiefly to the 225 and 350 ft. levels, with pockets cut at the 500 and 750 ft. horizons in preparation for extending lateral work to those levels, and a limited amount of work at the 1,000 ft. level. Stoping above the 350 ft. level has indicated a substantial widening of the ore-bodies, considerably increasing the ore reserves. The Treadwell Yukon is actively pushing exploration work on the 1,500 ft. level of the Errington mine, but so far without encountering substantial ore-bodies. The management, however, believe that the lower levels will prove somewhat similar to the 300 and 500 ft. horizons, where large tonnages of ore were located following earlier disappointments.

Porcupine.—The Hollinger Consolidated during 1930 produced gold and silver to the value of $10,263,505 from 1,625,868 tons of ore, with an average recovery of $6·31 per ton. This is a net gain of 8·8% over the production figures of $9,433,767 for the preceding year. Income from other sources amounted to $639,426, bringing the total up to $10,920,931. After deducting operating costs and allowances for taxes, net profits amounted to $4,083,881. Dividends of $3,444,000 were paid, leaving $639,881 to be added to surplus account. Development operations during the year were sufficiently extensive to do more than provide for mill requirements, increasing the value of the ore reserves to $48,805,685, as compared with $47,819,389. The favourable results obtained in exploration work on the 3,000 ft. level have encouraged the management in its active campaign of deep development, since it has now been proved that mineralization continues below the porphyry intrusion, which at one time appeared to be the end of gold values. The new mill at the Dome mines is working at capacity of 1,500 tons daily, some difficulties which were at first experienced having been successfully overcome, recovery being between $6·80 and $7 a ton. The ore reserves are being increased by the opening up of new ore-bodies—one of which is stated to show more than average grade over a length of 800 ft. and a width of 10 ft. The Vipond is actively carrying on a campaign of deep development—the geological conditions shown on the Hollinger property adjoining warranting the conclusion that mineralization persists at depth. The ore reserves have now been built up to $1,400,000, the ore averaging $8 to the ton. The McIntyre Porcupine is steadily increasing its output, production for the quarter ending December 31 last amounting to $1,220,362, as compared with $1,216,567 for the previous three months. Operating costs were $644,208 as compared with $636,961 and net earnings before depreciation were $541,543. Underground work is going forward actively—steadily adding to the ore reserves. Operations are being carried on at a limited scale at the March gold mine. The management plans to deepen the present workings at the 675 ft. level and carry out more extensive development. Ore values are not high, but the low operating cost leaves a margin of profit.

Kirkland Lake.—The Lake Shore mill during the three months ending December 31 last treated 185,097 tons of ore, with a recovery of $2,290,000, as compared with $1,800,000 recovery from 122,515 tons treated in the preceding quarter. The mill is now treating an average of 2,200 tons per day, which will be increased later in the season. The installation of another ball-mill will increase the milling capacity to about 900,000 tons of ore annually. At the Teck-Hughes good progress is being made with the installation of the third unit of the mill which will bring the capacity up to 1,300 tons daily. At the lower levels recently reached work is revealing continuity of the high-grade ore and is adding to the ore reserves at a rapid rate. The production of the Wright-Hargreaves for the year 1930 was valued at $2,431,896, from the treatment of 220,430 tons of ore, with an average recovery of $11 per ton. Development placed 421,000 tons of ore in sight—ore reserves standing at 619,605 tons. During the current year sinking will be carried on to 3,000 ft. in depth, opening up four new levels. Development at depth has encountered ore carrying $15 gold to the ton. The mill is operating at the rate of 750 tons of ore per day and an increase in its capacity may be made before the end of the year. Shaft sinking at the Sylvanite mine is being continued to the 2,500 ft. level, from which lateral work will be undertaken to cut an important ore-body indicated by diamond drilling. Production is at the rate of about $80,000 monthly and, as a result of the enrichment in the more recently developed ore, it is stated that ore reserves now average $10 a ton. Kirkland Lake gold mine is continuing its programme of deep

development and the winze is being put down below the 4,300 ft. level. Several new levels will be opened up at depth, the average grade of the ore now being treated is $12 to the ton, but higher values are being taken from the lower levels. At the Telluride, production is showing steady improvement, mill-heads averaging about $15 to the ton in gold, and about 4% copper. Shipments of concentrates will shortly be made regularly to the Noranda smelter. The Tough-Oakes has been taken over under option by the Premier Gold Mining Company and is being dewatered in preparation for an aggressive development campaign. The mill of the Barry Hollinger is treating ore of an average grade of $12 to the ton. Development is proceeding satisfactorily, an important body of $20 ore being opened up on a sub-level below the 1,500 ft. horizon. The winze has been put down below the 1,800 ft. level.

Rouyn.—Noranda Mines is giving much attention to gold production—its output of bullion in December being reported at approximately $400,000 and it has continued at about this level in January. Most of the high-grade ore going to the mill is drawn from an ore-body between the 100 ft. level and the surface. This body comprises some 60,000 tons of ore in which values are erratic and the high-grade production during the last two months is due to mining of a rich pocket. There are other gold ore-bodies in the mine, the largest of which is on the 850 ft. level, and gold is also found in conjunction with copper in the copper bodies. About two-thirds of the smelter capacity is being used on copper-gold ores, the remainder being used for the treatment of purely gold ore. The new plant of the Canadian Copper Refiners Ltd. at Montreal East has been completed and is ready to receive shipments of concentrates from Noranda for treatment. This refinery, which is controlled by the Noranda Mines, has a capacity of 75,000 tons annually, whereas the available supply from Noranda and the Hudson Bay Mining and Smelting Company at the current rate of smelter production is approximately about half this figure, but, as the Noranda has for some time been storing its output of concentrates, initial shipments will for some time be higher than later on when Noranda will be dependent on its curtailed output to keep the refinery in operation. Operations at the Granada Rouyn gold mine have been interfered with by flooding, but this difficulty has now been overcome and the mill is treating around 60 tons per day of ore averaging $15 per ton. Tonnage coming from the stopes along the central area on the 625 ft. level is exceeding expectations, and the gold content of the ore at $15 to the ton is well maintained. An encouraging feature is that the width and value of the ore has steadily increased with depth. The Pandora is preparing to install a steam mining plant and has planned an extensive programme of underground work—diamond drilling having proved a large body of commercial ore. Work on the 300 ft. level of the O'Brien Cadillac property is stated to have cut the downward continuation of the main vein. The management is considering plans for mill equipment and will continue operations on a large scale. At the Siscoe gold mine lateral operations at the 300 and 450 ft. levels have encountered a large body of commercial ore. The new shaft is to be put down to the 650 ft. level.

Manitoba.—Production at the Flin Flon mine of the Hudson Bay Mining and Smelting Company is now on a steady basis and shipments are going forward at regular intervals, approximately 50 tons of blister copper and 40 tons of electrolytic zinc being shipped daily. The smelter is treating close to 3,000 tons of ore daily, two thirds of which is coming from the open-pit, which will be the main source of supply until it has reached a depth of 300 ft. The balance of the ore is coming from the mine proper. Production will be maintained at its present rate for some time. Exploration by diamond drill has been resumed. The construction programme of the Sherritt Gordon has almost been completed and the concentrator will be ready to start production this month. It has been officially announced that the mine will go into production as soon as possible, but only one unit of the three in the mill will be operated at first. The mine has been developed to the stage where there is a very large tonnage of ore ready for treatment. A syndicate of mining and financial men have undertaken to finance San Antonio Mines Ltd. in Central Manitoba and mining operations will be resumed without delay. Development work on the 600 and 700 ft. levels, prior to the shutdown owing to financial difficulties, revealed good gold values. A crew of 30 men have been sent in and active development will be proceeded with.

CAMBORNE

March 5.

The Tin Industry.—Sir Cecil Budd was the principal guest of the Redruth Chamber of Commerce at their recent annual dinner. Being chairman of the Cornish Tin Smelting Company and a director of the Imperial Smelting Corporation and a number of other well-known metallurgical companies, Sir Cecil's acquaintance with the tin industry is considerable. Naturally his remarks on the position and prospects of that industry were anticipated with much interest. He expressed the opinion that the tin industry was suffering from the uninformed talk of three or four years ago, which created a belief that a famine in tin was approaching, but there never was any such thing in prospect. The worst thing that could happen to tin mining was that tin should ever reach £300 a ton again. That was bad for miner, smelter and user. Progress, however, has been made towards establishing the Government scheme for restriction since the date of the Redruth Chamber of Commerce annual dinner and those chiefly concerned in the welfare of the Cornish mines welcome that progress. The advance in the price of tin from the low point of about £104, reached just before last Christmas, to the £122 now recorded fosters the hope that before long a resumption of full active operations will be justified at South Crofty and Geevor. Were this to be the case and if full-time instead of half-time operations were resumed at East Pool it would give immediate employment to over a thousand of West and Mid Cornwall's unemployed, now exceeding 10,000 in number.

East Pool is still the only mine in Cornwall where production has not been entirely suspended. During January 2,976 tons of ore yielded 41·5 tons of black tin and 20 tons of arsenic which together realized £3,097, equivalent to a tonnage value of £1 0s. 10d.

"At what price for tin will the Cornish mines be justified in resuming full operation?" is an important question. If a full measure of development is carried on, as heretofore, in such mines as East Pool and South Crofty about £170 to £180 is essential. Probably Geevor could do well at a little lower level. In any case there is no doubt that at £170 to £180 the three mines named would be perfectly justified in resuming normal work. This can scarcely be said of other suspended mines.

PERSONAL

A. L. Bell has left Mexico and, after touring in the United States, is returning home.

R. S. Botsford has left for Canada.

G. W. Campion has left for West Africa.

F. H. Cothay is home from Nigeria.

H. C. Curwen has left for South Africa.

G. A. Davenport is returning from South Africa.

H. G. D. Dixon has returned from Spain.

W. A. Edwards, after visiting Bolivian mines, is returning to Chile.

W. A. Hardy has returned from India.

A. C. Harrison is returning from Burma.

Vincent T. Hockin has returned to Tanganyika.

J. M. Iles has left for Canada.

R. Underwood Jarvis has returned from the United States.

Robert Macfee is home from France.

W. E. Sevier is leaving for the Gold Coast.

J. E. Snelus has left for Nigera.

Jack Spalding is returning from Southern Rhodesia.

R. J. S. Waddington is returning from South Africa.

J. S. Williams is returning to India.

F. H. Mason, who for the past eleven years has been the Vancouver correspondent of The Mining Magazine, died suddenly on February 7 at his home in Victoria. He had acquired a well-deserved reputation as a writer who was clear, concise, and accurate, and one who did good service for the mining industry of British Columbia.

Edward Walker, who died at his home at Kenton on February 10, aged 65, will long be remembered by mining men throughout the world for his genial courtesy and helpfulness. His association with mining covered nearly 40 years, for it was in 1892, whilst in the United States, that he met R. P. Rothwell and joined the staff of the *Engineering and Mining Journal*, assisting with the production of the first volume of *The Mineral Industry*. Returning to England in 1893, Mr. Walker became London representative of the *Engineering and Mining Journal*, a position he held, notwithstanding several changes in the management, till 1907. At this period there was a desire on the part of a number of mining men in London for a technical paper and as the result of Mr. Walker's representations T. A. Rickard and Edgar Rickard came to England in June, 1909, and September of the same year saw the first issue of The Mining Magazine. Mr. Walker was appointed assistant editor and he occupied this position till October, 1916, when, on a change in the management, he succeeded H. Foster Bain as editor. This post he held, with credit to himself and benefit to the Magazine, till the end of 1929, his retirement being announced in the issue for January, 1930, although since the commencement of his illness in February, 1929, he had been unable to undertake any heavy or responsible work. His helpful advice, however, was always available and he will be missed by none more than by those with whom he cordially worked for the past 14 years. Coming of a Lancashire Quaker family, Mr. Walker took his degree of M.Sc. at Owen's College and at one time contemplated entering the medical profession. He would, however, have made headway in any profession with which he might have become

associated, for he had not only a wonderful memory, but a personality that endeared him to all. Although geology might be said to be his strong point—and he was a Fellow of the Geological Society—Mr. Walker was well-informed on mining matters generally and was always ready and willing to pass this information on. In this connexion he will be missed, not only by the younger men, but by many occupying prominent positions, for all benefited more or less as the result of consulting him. Apart from mining there were few subjects on which Mr. Walker was not well versed and one can only regret that all the knowledge he possessed and was able and willing to impart has passed with him.

TRADE PARAGRAPHS

International Combustion, Ltd., together with Underfeed Stoker Co., Ltd., and Combustion Steam Generator, Ltd., have moved to Aldwych House, London, W.C. 2.

Henry Bath and Son, Ltd., of London, Liverpool and Swansea, issue their customary chart showing the changes in the price of copper, spelter, tin and lead for the period from 1920 to the end of 1930.

Wallwin Co., of Saltisford Ironworks, Warwick, send us a leaflet drawing attention to further particulars with regard to their pump for handling solids, a description of which appeared in our June issue.

Lead Industries Association, of 420, Lexington Avenue, New York send us a further issue of their publication *Lead* and ask us to draw attention to the fact that copies of this periodical can be obtained by any interested persons.

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, send us booklets devoted to the following: The Skinner multiple-hearth roasting furnace, the Kirkless slurry separator, and to steel waggon work and chimneys and tanks, such, for example, as cyanide tanks.

J. Pohlig, A.G., of Koln, Germany, publish an illustrated booklet giving examples of their aerial ropeways, electric overhead runways, steel band conveyors, bucket conveyors, and other conveying and elevating appliances, which clearly shows the number and variety of installations which have been erected by this firm.

Petters, Ltd., of Yeovil, have sent us a number of publications printed in Spanish for use at the British Empire Trade Exhibition now being held at Buenos Aires. One of these is devoted to their Atomic Diesel cold starting oil engines which have already been described in these columns, and another to their aircraft specialities.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, send us booklets devoted to double-shell rotary dryers for all ore, sand and gravel drying operations, and also to Stag pulverizing cylinders or intermittent ball mills suitable for crushing wet or dry a variety of materials. These machines are also suitable for use as mixers.

Demag, of Duisburg, Germany, in the January issue of their *Demag News* have an article describing high-pressure compressors for charging compressed-air locomotives. It is fully illustrated with photographs and cross sectional drawings. Following this is a description of the locomotives themselves which have been found suitable for underground haulage. Another article describes the Demag loading shovel, also suitable for underground operations.

Wilfley Mining Machinery Co., Ltd., of Salisbury House, London, E.C. 2, inform us that they have acquired the goodwill of the engineering business of the Wilfley Co., Ltd., including all rights in the well-known Wilfley table and other specialities for mining and metallurgical purposes. The new company has manufacturing facilities that will enable it to supply equipment to satisfy every requirement and new specialities are about to be introduced.

John Chatillon and Sons, of Cliff Street, New York, send us particulars of another automatic weighing device, a companion machine to that described in our May, 1930, issue. This is the Telepoise feeder scale which will weigh the material passing over a short conveyor and telegraph the weight to a register located at any distance away from the scale. The register is a continuous type, arranged to operate a 24 hr. time chart recorder which furnishes a filing record of daily operation. Like the conveyor scale, it also indicates the ton rate per hour.

Ingersoll-Rand Co., Ltd., of 165, Queen Victoria Street, London, E.C. 4, have sent us a copy of their mining map of Southern Africa, which indicates mines, mineral concessions, power stations, railways (completed and projected) ports, etc. It is printed in eight colours on a sheet measuring 30 in. by 36 in., the scale being 70 miles to the inch. The various mineral deposits are picked out in different colours and enlarged sections deal with the Witwatersrand goldfields and a section of the Northern Rhodesia copper field. Copies can be obtained from the Company.

Mining and Industrial Epuipment, Ltd., of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment:—For England: One 3 ft. by 5 ft. single surface, type 39, Hum-mer electric screen for granite chippings; and one 100 sq. ft. "Rovac" backwater filter to handle 12,000 gallons paper-machine backwater per hour. For Portugal: One 4½ ft. by 13 ft. Hardinge mill for tin ore in quartzitic gangue. For France: One 6 ft. Raymond separator for carbon black. For Russia: 16 10 ft. by 60 in. Hardinge mills for anthracite.

Straub Manufacturing Co., Inc., of 507, Chestnut Street, Oakland, California, issue a leaflet describing some of their specialities. These include the Little Giant rib-cone mill which answers the demand for a small but practical mill for prospectors, small mines, regrinding, clean-up work, pilot mills, etc. It is made entirely of steel, complete with the exclusive built-in screen classifier head. The mill regrinds its own oversize within itself, discharging a sized and finished product direct to the next sequence. Other specialities include Straub "Over-Built" crushers in various sizes for coarse crushing, Overstrom universal shaking tables, and Kraut flotation machines.

Lincoln Electric Co., Ltd., of Cleveland, Ohio, have issued particulars of a competition which they are promoting with a view to increasing the knowledge of the adaptability of arc welding to industry and more especially in welding for the redesign of existing machinery in cast iron or rivetted steel. The advantages of arc welding are not properly understood in many quarters and it is believed that when they are understood

great reductions in cost will result from their use as well as improvements in the product obtained. It is a further purpose of the contest so to frame the rules for judgment of the papers submitted that consideration is given to the proportionate saving made by the application of arc welding. Various large cash prizes are offered and the competition is open to anyone except the Company's employees. Detailed particulars may be obtained by those interested from the Company.

Samuel Osborn and Co., Ltd., of Clyde Steel Works, Sheffield, inform us that the demand for Osborn S.O.B.V. " Solidend " tools is rapidly increasing. These tools are supplied in the finished state, that is forged, hardened and ground, ready for use, but as many users prefer to do their own forging and heat treating the firm are now supplying blanks. These consist of a 50 ton tensile steel shank, having a full section of S.O.B.V. welded on, the size varying with the size and shape of the tool. Usually with a 1 in. square tool a 1 in. cube of S.O.B.V. is supplied. Experience has shown that these " Solidend " tools and blanks can be forged and heat treated without affecting the weld, and tools have been hammered on the anvil through 180° without a sign of fracture. Among the advantages claimed for these tools over other tipped tools is that the weld is quite unbreakable and the tips do not come loose.

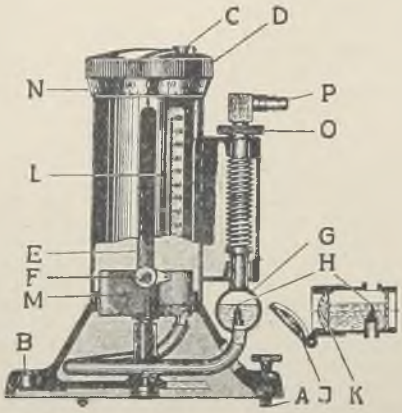
Glenfield and Kennedy, Ltd., of Kilmarnock, have issued particulars of a set of two electrically driven high lift three-throw ram pumps recently supplied to Roan Antelope Copper Mines. The liquid to be pumped, against a head equivalent to 1,450 ft. of water, is a thick sludge containing about 30 per cent. solids, and for this severe work valves and valve boxes have been specially constructed. The pumps have rams 7 in. in diameter and 10 in. stroke and run at 50 r.p.m. equivalent to a 125 b.h.p. and pump h.p. of 84. Also the normal duty is 200 gal. per min. of mixed water and solids of a combined weight of 14·5 lb. per gal. against a static head of 950 ft. Generally the mixed product per minute is 140 gal. of water (10·0 lb. per gal.) and 60 gal. of sludge (25·0 lb. per gal.) corresponding to the above average of 14·5 lb. per gal. The pump is driven by a Crompton Parkinson motor of 125 b.h.p., 3 phase, 3,300 volts, 50 cycles, at 485 r.p.m. through double helical wheel gearing (single reduction) and a Wellman-Bibby flexible coupling.

Westinghouse Electric International Co., of 2, Norfolk Street, London, W.C. 2 (Head Office : New York), send us a copy of their *Westinghouse International* for the first quarter of the year. This contains an interesting review of the major achievements of the company and developments in electrical technology during 1930. Of special interest herein is a reference to the hoist at the Frood mine of the International Nickel Company which is described as the largest single motor hoist in the Western Hemisphere. Its 17 ton bucket and load is elevated at the rate of 3,000 ft. per minute and starting from rest it reaches this speed in 15 secs. Its daily capacity is 10,500 tons from the 1,200 ft. level, 7,000 tons from the 2,200 ft. level, and 3,500 tons from the 3,800 ft. level. Its shunt-wound driving motor, which was built by the Canadian auxiliary of the organization, is direct connected to the 12 ft. winding drum and is rated at 3,200 h.p., 600 volts, 79 r.p.m. Variable voltage control with automatic slow-down is employed. The corresponding motor generator set of 2,500 k.w., at 750 r.p.m., has an 11 ft. flywheel weighing 40 tons.

Wilkinson Process Rubber Co., Ltd., of Batu Caves, Selangor, F.M.S., who are represented in this country by **Wilkinson Rubber Linatex, Ltd.,** of 1-4, Great Tower Street, London, E.C. 3, have published a fully illustrated booklet describing their Linatex material. This abrasion resisting rubber material has already been referred to in these columns. The outstanding feature of it is that it retains its resilience after ordinary rubber has become hard and for many purposes useless. The speciality is manufactured in Malaya where supplies of rubber latex are, of course, easily obtainable and where incidentally many of its applications have been worked out, but it is exported from that country in the form of rolls with or without reinforcing. From these rolls the simpler forms of liner can be supplied without further work, but the manufacturers and their agents maintain a staff of men trained in building up Linatex into the more complicated shapes, and engineers qualified to advise on correct application and design. The most obvious use for Linatex is the lining of launders carrying sand and other abrasive material and water. Similarly, it can be used for lining chutes and pipes, and it is interesting to note in connection with the latter that it has been demonstrated that a rubber lined pipe offers less frictional resistance to the flow of water than does an unlined pipe. Another application which has been tried out with success is for lining the bottom of skips on a South African mine. Again it has been successfully employed for sand pump liners and an interesting example is quoted of a 3 in. Wilfley sand pump working on mill tailings delivering 180 tons of sand daily through a 4 in. Linatex lined pipe, 800 ft. long, with a total head of 23 ft. Up to date four hard iron impellers have been renewed but the lining shows no sign of wear whatever. The booklet goes on to give directions for methods of fastening Linatex material by means of rivets and screws.

Askania Werke, A.G., of Berlin, through their agent in London, Mr. O. G. Karlowa, of Abford House, Wilton Road, London, S.W. 1, inform us that the instrument which was mentioned in the article on fan testing appearing in the Mining Digest in our last issue is manufactured by themselves. The Minimeter permits the determination of the smallest pressures with an accuracy of 1/100th m.m. such as is said to have never been previously attained. They send us a leaflet describing it and by way of supplementing the information already published we reproduce here a diagrammatical section which the following description will serve to explain. To use the water column Minimeter, the instrument must first of all be set truly horizontal by means of the levelling screws A and the level B which is let into the base of the instrument. Bring the pointer F to zero and admit water through the nipple P until the surface of the water is about level with the extremity of the pointer H, which can then be brought dead level with the surface, that is to say, to the zero position, by turning the screw O until the pointer H, when seen in the mirror J and magnified by the lens K, just touches its reflected image. The pressure to be gauged is then connected up to the nipple P by means of a length of rubber tubing ; if differences of pressure are to be determined, the lower pressure is connected to F. As soon

as the pressure is on, the level of the water in the sighting container G will fall and the equalizing container M must then be raised by turning the knob C or the milled ring D, to which it is connected, until the surface of the water has resumed its original level, i.e. until the pointer H again just touches its reflected image, when the pressure in



THE ASKANIA MINIMETER.

millimetres of water column can be read off on the scale L or on the fine division scale N. The latter has 200 sub-divisions, each sub-division representing the one-hundredth part of a millimetre, so that one complete revolution of this scale represents two millimetres of water column.

BRITISH INDUSTRIES FAIR

R. White and Sons, of Widnes. Lancs, were demonstrating by means of models their aerial ropeway systems.

Davidson and Co., Ltd., of Belfast, had a display of centrifugal and propeller fans, air washers, flue dust collectors, and suchlike.

Frederick Parker, Ltd., of Leicester, were showing crushing, screening, conveying, and elevating equipment, contractors' plant and suchlike.

W. and T. Avery, Ltd., of Soho Foundry, Birmingham, had a comprehensive display of weighing, measuring, counting, and testing machines for all purposes.

Marshall, Sons, and Co., Ltd., of Gainsborough, were showing several Diesel tractors and also a single cylinder horizontal cold-starting Diesel engine of 65 b.h.p

R. A. Lister and Co., Ltd., of Dursley, Gloucester, were showing a variety of light petrol, paraffin and other oil engines, pumping plants and auto trucks for light transport.

British Oxygen Co., Ltd., of Angel Road, London, N. 18, were demonstrating gas welding and oxygen cutting equipment for the fabrication and repair of industrial plant in any metal.

Allen-Liversidge, Ltd., of Victoria Station House, London, S.W. 1, were exhibiting oxy-acetylene welding, cutting and leadburning equipment, electric welding plant and acetylene lighting.

United Steel Companies, Ltd., and associated companies, of Sheffield, had a representative exhibit of steels for all purposes, including bars, strip, billets, forgings, stampings, wire and structural steel.

Ewart Chainbelt Co., Ltd., Derby, makers of conveying and elevating plant were demonstrating chains made from Ley's special quality malleable iron and also sprocket wheels and elevator buckets.

Alfred Herbert, Ltd., of Coventry, had a working exhibit to show the application of an Atritor coal pulverizer for firing a forge furnace and a similar machine was shown open for inspection.

W. C. Holmes and Co., Ltd., of Huddersfield, in addition to special extractors, were showing by means of models and photographs examples of Holmes-Connersville meters, exhausters, boosters and blowers.

George Ellison, Ltd., of Birmingham, had a wide display of switchgear, distribution switchboards, control gear for small motors, industrial and flameproof mining circuit breakers and starters, and controllers.

Gandy Belt Manufacturing Co., Ltd., of Seacombe, Cheshire, were showing balata, leather, hair, solid woven and rubber belting, together with all accessories, and also hydraulic leathers, banding and pulleys.

R. and J. Dick, Ltd., of Glasgow, were showing their " Dickbalata " belting for power transmission, conveying, and elevating purposes, various forms of " Dixit " belting for acid and high temperatures, and also driving rope.

Coventry Chain Co., Ltd., of Coventry, and **Hans Renold, Ltd.,** of Manchester, were exhibiting jointly on a stand transmission chains, couplings and clutches, and gear reduction boxes, and conveyor and other chains.

Goodwin, Barsby, and Co., Ltd., of Leicester, were showing examples of their quarrying, road making and contracting plant, including stone crushers, screens, elevators, conveyors, and also gravel washing and screening plant.

Sturtevant Engineering Co., Ltd., of 147, Queen Victoria Street, London, E.C. 4, were represented at the Exhibition but were not, however, showing any of their products of interest to mining and metallurgical engineers.

Reyrolle and Co., Ltd., and **J. H. Holmes and Co., Ltd.,** both of Hebburn-on-Tyne, were jointly represented on a stand devoted to metal-clad switchgear and a variety of other electric apparatus for power station and sub-station purposes.

National Gas Engine Co., Ltd., of Ashton-under-Lyne, were showing vertical and horizontal crude oil engines, notably one single cylinder horizontal engine of 17 b.h.p., and a four cylinder vertical engine which develops 100 b.h.p. at 600 r.p.m.

Ransomes and Rapier, Ltd., of Ipswich, were represented at the Exhibition by a stand on which they were showing photographs drawing attention to their excavating machinery which has been frequently described in these columns.

Thomas Locker and Co., Ltd., of Warrington, had as their principal exhibit a " Supreme " electric vibrating machine described in these columns in our April, 1930, issue, also " Durite " wire screens, perforated metal plates and screens, and woven wire conveyor bands.

Stewarts and Lloyds, Ltd., of Birmingham, makers of weldless steel, lapwelded, wrought iron, and steel tubes and fittings, also bitumen-lined steel tubes, were showing examples of their products and Victaulic joint tubes, together with various steel castings and sections.

P. B. Sillimanite Co., Ltd., of Salisbury House, London, E.C. 2, were showing many examples of the products made from this hard, tough and most refractory material, including gastight tubes, electric insulators, refractory cements, both hot and cold setting, etc.

Vickers-Armstrongs, Ltd., of Newcastle-upon-Tyne and Barrow-in-Furness, manufacturers of hollow and solid rods and sections, rolled metals, chill cast solid and cored bars, castings and forgings in brass, manganese bronze, gunmetal and P.M.G. metal, were exhibiting various examples of their products.

Fielding and Platt, Ltd., of Gloucester, were showing a single cylinder horizontal cold starting engine of 60 b.h.p. and a two cylinder vertical similar engine of 50 b.h.p. The latter is a recent development which is also made in three and four cylinder sizes developing respectively 75 and 100 b.h.p.

Johnson, Matthey, and Co., Ltd., of 73-82, Hatton Garden, London, E.C. 1, were represented at the London section of the Fair. In their stand they were showing examples of their platinum, palladium, gold and silver products and especially stills and evaporators made of pure silver for special process work.

G. D. Peters and Co., Ltd., of Windsor Works, Slough, manufacturers of " Wilson " plastic arc welding plant and " Colour-Tipt " welding metals and all welding accessories, had a representative exhibit. We propose to describe here in a subsequent issue this welding process and equipment in some detail.

Bromford Tube Co., Ltd., of Aston, Birmingham, had a comprehensive display of hot finished weldless steel tubes of from $\frac{3}{4}$ in. to 15 in. bore, in lengths up to 50 ft., gas and water mains, and loose flanged tubing, including the Carlton pipe joint. Associated with this firm were **Tubes, Ltd.,** also of Birmingham.

British Insulated Cables, Ltd., of Prescot, Lancs., manufacturers of copper and aluminium wires, sheets and strips, were exhibiting these and other products, including electric cables and wires, electric welders and rivet heaters, meters, static condensers, primary batteries and overhead equipment for tramways and railways.

Thomas Firth and Sons, Ltd., of Sheffield, occupied two large stands which were devoted principally to demonstrating the numerous applications of Firth Staybrite and stainless steels, also a comprehensive range of engineers' tools, drills, cutters, reamers and files, and also Insto metal saws with teeth of high speed steel.

Whitecross Co., Ltd., of Warrington, in a comprehensive range of their wire products, were making a feature of locked coil, and flattened strand mining ropes, a particular feature of which is the protection from internal corrosion by filling the interior with an anti-corrosive lubricant and constructing the outer cover as nearly waterproof as possible.

Tangyes, Ltd., of Birmingham, were showing several examples of different sizes of their horizontal single and double cylinder, heavy fuel oil engines, all in operation, and various other of their products, including pumping outfits such as treble ram, centrifugal and turbine pumps, also gas producers for obtaining gas from all such fuels as husks, tree bark, cocoanut shell, and suchlike.

Babcock and Wilcox, Ltd., of Babcock House, Farringdon Street, London, E.C. 4, had two oil engine exhibits, one a 15 b.h.p. medium compression type, single cylinder, horizontal engine, the other a 33 b.h.p. cold-starting engine. The former type of engine was originally built by Clayton and Shuttleworth, of Lincoln; the latter are made also in sizes of 55, 80, 100 and 150 b.h.p.

Murex Welding Processes, Ltd., which incorporates Alloy Welding Processes, Ltd., and Premier Electric Welding Co., Ltd., of Forest Road, Walthamstow, London, E. 17, were demonstrating various types of welding equipment, including arc welding plant, welding transformers, atomic hydrogen welding plant, " Flexin " continuous welding system and a variety of electrodes and metal welding.

Bureau of Information on Nickel of the Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, were making a particular feature of a demonstration by means of samples and pictures of the extraction of nickel from its ore and the properties of nickel and its alloys and their many applications in industry. As usual, the display was admirably executed and singularly instructive to the layman.

J. and F. Howard, Ltd., of Bedford, were for the first time showing their Diesel locomotives. Here was a three ton crude oil locomotive fitted with a two cylinder Blackstone high speed engine, described elsewhere in this issue, which is representative of a range of sizes from 2 to 12 tons fitted either with petrol paraffin or Diesel oil engines. These locomotives are used for all sorts of outdoor transport about works and mines.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, were showing on their stand the many and varied applications of perforated metal. They had also examples of their woven wire work and special fabricated metal products such as processing retorts as used in certain chemical and allied industries. In addition they had on exhibit examples of their steel furniture such as filing cabinets, cupboards, etc.

Moler Products, Ltd., of 49, Moorgate, London, E.C. 2, were showing many examples of their Fos-al-sil insulating bricks, slabs, and other shapes. In order to indicate the heat losses through various types of walls they were operating a small furnace, one side of which was built of firebrick and on the opposite side are Fos-al-sil insulated slabs with joints of Fos-al-sil mortar, the end built of insulating bricks with ordinary mortar joints and the door of insulating concrete.

Imperial Chemical Industries, Ltd., of Imperial Chemical House, London, S.W. 1, in addition to the exhibit of the Mond Nickel Co., Ltd., this organization was represented at the Birmingham section of the Fair by the **Cassel Cyanide Co., Ltd.,** who were demonstrating a plant for case hardening by means of molten sodium cyanide. In the London section of the Fair the group occupied a large stand in the chemical section wherein in addition to a cinematograph exhibition showing the activities of their various associated industries, they had a wide display of products arranged in groups according

to the parts of the Empire in which these are used.

Wild-Barfield Electric Furnaces, Ltd., of Holloway, London, N. 7, had in operation a Gibbons-Wild-Barfield furnace said to be the largest of its kind demonstrated at an exhibition, measuring 9 ft. 6 in. long by 8 ft. wide by 6 ft. high, having a maximum input of 110 k.w., the power to maintain 900°, being only a small fraction of this amount. The heating elements are of heavy gauge nickel chrome situated not only in the walls, roof and floor, but also in the door in order to extend the useable length of the chamber to a maximum, those under the floor being enclosed while the remainder are exposed. The door is electrically operated by means of push button controls.

W. and J. George, Ltd., of 157, Great Charles Street, Birmingham, makers of laboratory apparatus and instruments of every description, were showing a considerable variety of their products. Our attention was especially drawn to an analytical balance of all British manufacture which the Company are endeavouring to market at a price which compares favourably with that of their various foreign competitors. We also noticed an ingenious microscopic projection outfit which consists in means for attaching a projector lamp underneath a microscope table, with the aid of which a slide can be projected on to a screen set at any convenient distance according to the size of image required for demonstration purposes.

Crossley Bros., Ltd., of Openshaw, Manchester, were showing a number of their horizontal and vertical oil engines, among which of principal interest was a single cylinder fuel oil engine of 15 b.h.p. which has not hitherto been shown. It is typical of a range of similar horizontal engines developing 9, 13 and 15 b.h.p. Other exhibits on this stand included a four cylinder horizontal oil engine of 88 b.h.p. of the type described here in our December, 1930, issue, a three cylinder vertical engine of 82 b.h.p. and a twin cylinder horizontal engine of 48 b.h.p. The vertical engine is a compressorless Diesel type which in this case was direct coupled to a 50 k.w. d.c. dynamo running at 450 r.p.m. All these engines were running on heavy crude oil.

Petters, Ltd., of Yeovil.—The particular exhibit on this stand was the latest type of 160 b.h.p. four cylinder Atomic Diesel, cold-starting vertical oil engine which was shown in operation for the first time. This Atomic Diesel engine is similar to that described in these columns under this heading last year. Subsidiary exhibits included a 130 b.h.p. twin cylinder Atomic Diesel engine, a 25 b.h.p. single cylinder engine and a number of smaller engines for various light duties. The large engine referred to, while particularly designed for marine purposes, is also made for other power generation uses and has a fuel consumption which varies from 0·41 lb. per b.h.p. hour in the larger sizes to 0·48 in the smaller, the sizes ranging from 50 b.h.p. twin cylinder to 480 b.h.p. six cylinder.

Macinlop, Ltd., of Manchester, were showing industrial rubber goods of all descriptions, including belting, hose, rollers, anti-corrosion linings and coverings. Special mention may be made of their air hose for conveying air at any pressure. This material is made up to 3 in. internal diameters in lengths up to 60 ft. Another variety is made up to 1½ in. diameter and in lengths up to 250 ft. and another 1½ to 3 in. diameter in lengths up to 60 ft. It is said on account of its flexibility to be non-kinkable. The outer cover is designed and compounded to resist severe abrasion such as is met with on the floors of mines and quarries. Special attention has also been paid to the inner linings with a view to avoiding the ill effects of oil which is carried in from the compressor.

Davey, Paxman, and Co., Ltd., of Colchester, were showing a new six cylinder vertical, heavy duty, oil engine direct coupled to a 200 k.w. d.c. generator. This engine has been built to meet the demand for an oil engine of higher speed. It develops 300 b.h.p. at a speed of 600 r.p.m. and is started by compressed air in the usual way. It is also totally enclosed by means of sliding shutters which are easily removable and afford access to the working parts. The pistons themselves are also easily removable for replacement. Another notable feature of this engine is the fact that the space occupied, particularly the space required for attention, is considerably reduced as is also the weight. This type is being made in sizes having 3, 4, 5, 6, 7 and 8 cylinders.

Hadfields, Ltd., of Sheffield, were showing the " Hecla " disc crusher which, as they point out, is an excellent all round machine for crushing all classes of material and one that will successfully deal with the hardest rock in mines. It is made in several sizes but the larger are generally used for ore crushing. The wearing parts are, of course, made of " Era " manganese steel. Also shown was a 24 in. single roll breaker especially suitable for coal. Examples of products made in their special steels " Era " HR the heat resisting steel, " Era " CR their non-corroding steel, and " Hecla " ATV, the latter especially suitable for steam turbine blading. Mining drill steel was also exhibited to demonstrate the difference between the sand cored hole and that produced by the Hadfield's metal core process with the advantages afforded by the latter.

Ruston-Bucyrus, Ltd., of Lincoln, were showing an example of their 1030 Diesel driven ¾ cu. yd. excavator, convertible to operate as shovel, dragline, grabbing crane, or crane. This unit was described in our July, 1930, issue. Another exhibit was of the " RoBuston " centrifugal pump for handling water-borne solids, which was described in our December, 1929, issue. On an adjoining stand **Ruston and Hornsby, Ltd.,** were showing examples of both their horizontal and vertical oil engines, the former class was exemplified by one of their airless injection, cold starting, crude oil engines of 22 b.h.p. These engines are manufactured up to 132 b.h.p. The vertical engines were represented by two high speed units, one known as mark " VQ " being a six cylinder unit running at 900 r.p.m., at which speed the normal working load is 96 b.p.h., and the other known as the " JP " being a four cylinder unit developing 135 b.h.p. and running at 1,000 r.p.m. A novel exhibit included one showing stages in the course of erection of oil engines which was demonstrated with one of the smaller Ruston totally enclosed oil engines known as the mark " PB." This engine was shown running and also being dismantled.

Blackstone and Co., Ltd., of Stamford, Lincs., occupied two large stands. The principal exhibit which took up most of the space on one of these stands was an 8 cylinder " V " type oil engine of 1,250 b.h.p. which was being shown for the first time. Its 8 cylinders consist of two 4's set at

angles of 45° to a perpendicular passing through the centre line of the crankshaft. This has been designed for direct coupling to generators or alternators, etc. It runs at 250 r.p.m. It is proposed to build these engines with 8, 12 and 16 cylinders. Other exhibits included standard horizontal single cylinder spring injection oil engines of 6 and 55 b.h.p. respectively. All these engines were running on heavy fuel oil. On the other stand, of special interest were Blackstone vertical high speed engines which have been fitted to lorries and other road vehicles. These oil engines were exemplified by an 18/20 b.h.p. (twin cylinder), a 36/40 b.h.p. (four cylinder), and two units of 55/60 b.h.p. (six cylinder). Also shown on this stand were two horizontal spring injection heavy oil engines, a single cylinder unit of 17 b.h.p. and a twin cylinder unit of 64 b.h.p. A number of smaller power units were also shown as also were pumping plants comprising Blackstone unchokeable pumps for handling all kinds of water-borne solids even though of a fibrous or abrasive nature. This unchokeable pump has wearing parts of manganese steel.

METAL MARKETS

COPPER.—The tendency of copper values during February was quite firm. Sentiment was cheered by the evidence that thanks to the serious reduction of output, the large American stocks were no longer being added to, whilst the signs of a general improvement in American industry caused a favourable impression. After easing from 9·75 cents per lb. to 9·50 cents early in the month, values subsequently rallied to 10·50 cents f.a.s. and producers anticipated being able to get it still higher in the near future. Towards the close of February there was quite a good demand in evidence on both sides of the Atlantic. The Japanese producers, who had been threatening to export in an unrestricted fashion, have been brought more or less into line with the Copper Cartel policy.

Average price of Cash Standard Copper: February, 1931, £45 8s. 3d.; January, 1931, £44 19s. 7d.; February, 1930, £71 10s. 3d.; January, 1930, £71 11s. 1d.

TIN.—Although prices fluctuated somewhat during February, the general tendency was firm, mainly because it was anticipated that the "quota scheme" would come into force at the beginning of March. This has proved to be the case, and the scheme, which envisages a basic world output of 145,000 tons per annum, is now in operation. Malaya, Bolivia, Nigeria and the Dutch East Indies are co-operating to control output and exports according to fixed percentages. Whilst of course the fact that the scheme is being applied is likely to strengthen the market, the statistical position is still poor and became even worse during February when "visible supplies" were increased by some further thousands of tons. Consuming demand remained quiet last month despite the improvement in the big American consuming industries.

Average price of Cash Standard Tin: February, 1931, £118; January, 1931, £115 17s. 7d.; February, 1930, £173 16s. 6d.; January, 1930, £175 10s. 10d.

LEAD.—The lead market was firm in February, but this was mainly caused by sympathy with the other non-ferrous metal markets, for although demand on the Continent certainly improved, this latter development was itself created by the upward movement in prices and not by any actual amelioration in the industrial position. Although it is announced that a big Australian producer of both lead and spelter may close down in April, it has to be remembered that the decline in the Australian exchange will tend to stimulate production at other properties there, including the new Mount Isa mines which will come into operation very shortly. Production seems to have been cut down substantially in America, but other producing countries have not yet followed suit to any extent. Whether the improvement in values will prove permanent has yet to be seen; much must depend upon the general business trend throughout the world.

Average mean price of soft foreign lead: February, 1931, £13 9s. 11d.; January, 1931, £13 17s. 9d.; February, 1930, £21 2s. 10d.; January, 1930, £21 11s. 1d.

SPELTER.—This market also enjoyed the firm conditions experienced by other metal markets, and at times there was quite good and sustained buying—apparently on behalf of speculators, for consumers remained listless owing to the continued poor demand for their own products. It was significant of the difficult position of producers that more smelters closed down in Germany during the month, whilst the situation of the Polish smelters, which were endeavouring to introduce wage-cuts, was stated to be very unfavourable. In Australia, meantime, output is likely to be stimulated by the depreciation in the Australian pound. The outlook for this metal remains obscure, but, of course, if the international scheme for controlling the tin industry succeeds this may push up the price of tin and such a development might react favourably on the markets for other metals, including spelter.

Average mean price of spelter: February, 1931, £12 9s. 11d.; January, 1931, £12 18s. 7d.; February, 1930, £19 9s. 10d.; January, 1930, £19 18s. 9d.

IRON AND STEEL.—The Cleveland pig-iron market has been quite cheerful of late, although demand from consumers has been quiet. The fact has been that the blast furnaces have not much difficulty at present in disposing of their current restricted output and the placing of certain substantial contracts for engineering material in the district has brightened the outlook considerably. Continental competition has weakened considerably, at least in the Tees-side area, although there is still heavy competition in Scotland. The minimum price of No. 3 foundry has remained at the level of 58s. 6d. per ton to which it was reduced during January. Hematite has been a slightly easier market, with East Coast Mixed Nos. quoted around 69s. The finished steel market was dull during February, this remark applying to both British and Continental material.

IRON ORE.—Apart from some American demand for Riff ore, business has remained very quiet and recently there has been a considerable curtailment in Swedish production. Best Bilbao rubio is still called for in odd cargoes, but, with easier freights, prices are down to about 15s. 6d. to 15s. 9d. per ton c.i.f.

ANTIMONY.—At the close of February English regulus was quoted at £36 to £42 10s. per ton. Chinese regulus commanded about £22 10s. to

LONDON DAILY METAL PRICES

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

	COPPER.									TIN.						ZINC (Spelter).			LEAD.						SILVER.		GOLD.	
	STANDARD.						ELECTROLYTIC.			BEST SELECTED.									SOFT FOREIGN.			ENGLISH.			Cash.	Forward.		
	Cash.			3 Months.																								
Feb.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s.	d.
11	46	3	1½	45	18	1½	48	16	3	—			117	11	3	118	18	9	12	12	6	13	15	0	15	5	0	12⅝	12⅝	84	11½
12	45	1	3	45	1	3	47	18	9	—			116	3	9	117	13	9	12	0	0	13	2	6	14	15	0	12 7/16	12 7/16	84	11½
13	44	19	4½	44	18	9	47	15	0	46	5	0	115	18	9	117	10	0	12	0	0	13	1	3	14	15	0	12⅜	12	84	11½
16	44	18	1½	44	16	3	47	15	0	—			114	16	3	116	6	3	12	0	0	13	2	6	14	15	0	12½	12	84	11½
17	45	16	3	45	11	10½	48	15	0	47	0	0	118	5	0	119	16	3	12	6	3	13	7	6	14	15	0	12½	12	84	11½
18	45	13	1½	45	10	7½	48	10	0	—			120	8	9	121	18	9	12	8	9	13	10	0	15	0	0	12 7/16	12½	84	10½
19	46	18	1½	46	18	1½	49	10	0	—			121	7	6	122	16	3	12	16	3	13	17	6	15	5	0	12 7/16	12 7/16	84	11½
20	46	17	6	46	16	10½	49	15	0	48	5	0	122	17	6	124	6	3	13	2	6	14	3	9	15	10	0	12 7/16	12 7/16	84	11½
23	47	1	3	47	0	7½	50	1	3	—			123	2	6	124	11	3	12	17	6	13	18	9	15	10	0	12½	12⅝	84	11
24	46	16	3	46	16	10½	50	0	0	48	5	0	122	8	9	123	16	3	12	15	0	13	18	9	15	10	0	12 11/16	12 7/16	84	11½
25	47	8	9	47	11	3	50	8	9	—			121	8	9	122	18	9	13	2	6	14	7	6	15	15	0	12⅝	12½	84	11½
26	46	15	7½	46	15	7½	49	15	0	—			120	16	3	122	6	3	12	15	0	14	0	0	15	10	0	12 7/16	12⅝	84	11½
27	46	11	3	46	16	10½	49	15	0	48	0	0	121	16	3	123	6	3	12	13	9	13	18	9	15	10	0	12⅝	12 7/16	84	11½
Mar.																															
2	47	4	4½	47	10	10½	50	8	9	—			123	2	6	124	12	6	13	0	0	14	6	3	15	15	0	12 9/16	12 9/16	84	11½
3	46	14	4½	46	19	4½	50	0	0	48	5	0	122	8	9	123	18	9	12	17	6	14	2	6	15	10	0	12⅝	12⅝	84	11½
4	46	8	1½	46	14	4½	49	18	9	—			121	8	9	122	18	9	12	17	6	14	3	9	15	10	0	12⅝	12½	84	10½
5	45	18	9	46	8	1½	49	12	6	—			121	11	3	123	1	3	12	16	3	14	2	6	15	10	0	13	12 11/16	84	11½
6	46	1	3	46	11	10½	49	12	6	47	10	0	122	11	3	124	2	6	12	16	2	14	2	6	15	10	0	13 1/16	13	84	11½
9	45	9	4½	46	0	7½	49	0	0	—			123	3	9	124	13	9	12	12	6	13	17	6	15	5	0	13⅛	13 5/16	84	10½
10	44	14	4½	45	5	7½	48	10	0	45	15	0	122	3	9	123	13	9	12	7	6	13	10	0	14	15	0	13⅛	13 1/16	84	11½

£22 15s. c.i.f. for shipment material, whilst for spot supplies the quotation was about £25 to £25 10s. ex warehouse.

ARSENIC.—Owing to the curtailed tin output in Cornwall there is very little arsenic offering, the price being nominally about £19 per ton f.o.r. mines. Mexican, high grade, however, is quoted at about £17 10s. c.i.f. Liverpool.

BISMUTH.—This remains a steady market at 5s. per lb. for 5 cwt. lots and over.

CADMIUM.—A moderate business continues to be done at about 1s. 9½d. to 1s. 10½d. per lb.

COBALT METAL.—There is not much doing, but the official price is still pegged at 10s. per lb.

COBALT OXIDES.—A quiet demand continues in evidence at the unaltered prices of 8s. per lb. for black and 8s. 10d. for grey.

CHROMIUM METAL.—The plating trade is taking very fair quantities, prices being maintained at about 2s. 7d. per lb.

TANTALUM.—Prices range from about £40 to £50 per lb.

PLATINUM.—Further easiness in quotations developed during February, refined metal now standing at £6 to £6 5s. per oz. Leading producers are again conferring with a view to stabilizing prices.

PALLADIUM.—Business has not been very brisk and prices have eased to £3 10s. to £4 per oz.

IRIDIUM.—An easier tone developed during February, sponge and powder falling to their present value of about £30 per oz. Buyers have been reticent.

OSMIUM.—A steady, if moderate, demand continues for this metal, prices being without alteration at £16 to £16 10s. per oz.

TELLURIUM.—In the absence of business quotations are nominally unchanged at about 10s. to 12s. 6d. per lb.

SELENIUM.—A moderate turnover is reported at the unaltered quotations of 7s. 8d. to 7s. 9d. per lb. ex warehouse.

MANGANESE ORE.—New business is limited to occasional odd cargoes, most buyers being very well covered under existing contracts. Prices are somewhere about 1s. 0¾d. per unit c.i.f. for best Indian and 10¾d. c.i.f. for washed Caucasian.

ALUMINIUM.—No improvement can be reported in this market, demand remaining at a disappointingly low level. Prices, however, are upheld at £85, less 2%, delivered, for ingots and bars.

SULPHATE OF COPPER.—English makers continue to quote £21 to £21 10s. per ton, less 5%, f.o.r.

NICKEL.—A fair business is passing, but the recently increased productive capacity of the leading producer is not being utilized to the full. Prices remain at £170 to £175 per ton.

CHROME ORE.—Only a moderate business is reported at the moment, but quotations show no change at 77s. 6d. to 80s. per ton c.i.f. for good 48% ores.

QUICKSILVER.—The temporary stringency of spot supplies mentioned in our last report has passed and quotations have eased to about £22 7s. 6d. per bottle, full terms, business remaining very limited.

TUNGSTEN ORE.—The poor demand for ferrotungsten has enabled buyers of tungsten ore to persist in a waiting policy, and sellers' prices have come down further still, the current value of forward shipments from China being about 11s. 6d. per unit c.i.f.

MOLYBDENUM ORE.—Although American 80% concentrates are still held for about 35s. to 35s. 6d. per unit c.i.f., odd parcels of Australian and Canadian have been offering at down to about 31s.

GRAPHITE.—Easier conditions have prevailed in this market recently, 85 to 90% raw Madagascar flake now being worth only about £19 to £21 per ton c.i.f. and 90% Ceylon lumps about £20 to £22 c.i.f.

SILVER.—On February 2 spot bars stood at 13¼d., but subsequently the market showed marked weakness, prices falling away to the record low level of 12d. per lb. on February 9. Dull conditions continued for a time, but towards the end of the month a rather better tone developed on Indian buying in anticipation of the increase in the duty on silver imported into India, and on February 28 spot bars closed at 12¾d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
February, 1930	783,086	35,102	818,188
March	852,089	37,281	889,370
April	831,996	36,610	868,606
May	876,893	39,320	916,213
June	847,352	40,515	887,867
July	871,468	41,184	912,652
August	878,474	42,607	921,081
September	860,311	42,865	903,176
October	884,632	41,929	926,561
November	844,038	40,715	884,753
December	867,202	41,290	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937

TRANSVAAL GOLD OUTPUTS.

	January.		February.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	95,000	£147,013	92,800	£129,155
City Deep	100,000	25,486	88,000	22,767
Cons. Main Reef	67,000	23,431	61,800	21,585
Crown Mines	256,000	80,695	237,000	75,035
D'rb'n Roodepoort Deep	46,700	15,392	43,200	14,381
East Rand P.M.	156,000	41,805	142,300	38,591
Geduld	85,000	27,231	79,000	25,386
Geldenhuis Deep	69,500	16,310	65,200	15,278
Glynn's Lydenburg	6,300	2,333	6,000	2,237
Government G.M. Areas	212,000	£409,867	187,000	£370,644
Kleinfontein	52,500	11,389	47,700	10,390
Langlaagte Estate	81,000	£115,108	74,000	£109,521
Luipaard's Vlei	32,000	8,102	29,500	7,465
Meyer and Charlton	18,400	£17,265	16,700	£16,808
Modderfontein New	164,000	70,349	150,000	64,368
Modderfontein B	71,500	23,066	67,000	20,053
Modderfontein Deep	46,000	23,422	42,000	21,272
Modderfontein East	72,000	21,144	65,500	19,656
New State Areas	81,000	£172,396	73,000	£158,210
Nourse	68,100	20,064	63,000	18,792
Randfontein	220,000	£257,352	200,000	£235,856
Robinson Deep	98,000	27,942	86,700	25,675
Rose Deep	62,000	13,305	58,000	12,373
Simmer and Jack	76,700	22,218	72,600	20,461
Springs	71,500	£146,416	63,400	£133,082
Sub Nigel	31,000	27,757	29,300	26,055
Transvaal G.M. Estates	15,216	4,963	14,200	4,330
Van Ryn	42,500	£42,507	40,000	£39,053
Van Ryn Deep	63,000	£100,140	60,000	£92,201
West Rand Consolidated	93,000	£107,206	85,000	£100,947
West Springs	71,500	£76,863	63,000	£68,022
Witw'tersr'nd (Knights)	57,000	£49,609	51,500	£46,444
Witwatersrand Deep	39,900	9,331	38,000	12,250

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.	£
Nov., 1929	2,559,450	28 3	19 11	8 4	1,071,199
December	2,528,000	28 3	19 11	8 4	1,058,231
January, 1930	2,618,600	28 2	19 9	8 5	1,103,718
February	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,250	28 7	20 1	8 6	1,084,504
May	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	—	—	—	—	1,171,456

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
February 28, 1930	196,752	15,495	6,584	218,831
March 31	200,134	15,350	7,002	222,316
April 30	202,434	15,109	5,565	223,108
May, 31	202,182	15,028	5,340	222,550
June 30	201,324	14,943	5,126	221,393
July 31	201,111	14,670	5,490	221,271
August 31	202,257	14,788	5,754	222,799
September 30	205,061	14,706	5,767	225,534
October 31	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850

PRODUCTION OF GOLD IN RHODESIA.

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

RHODESIAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,400	10,576	22,400	9,962
Globe and Phœnix	6,066	5,813	5,842	5,100
Lonely Reef	6,400	3,263	5,900	3,115
Luiri Gold	1,511	£3,119	—	—
Rezende	6,400	2,603	6,000	2,427
Sherwood Star	4,600	£11,390	4,200	£10,613
Wanderer Consolidated	15,900	4,061	13,800	£14,556

WEST AFRICAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	4,419	£8,368	3,909	£7,567
Ashanti Goldfields	11,750	13,971	11,000	13,319
Taquah and Abosso	10,382	£16,301	9,830	£15,733

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
February, 1930	31,307	1,354	350
March	27,946	2,502	382
April	36,652	1,812	1,081
May	32,967	3,480	580
June	41,738	812	673
July	34,174	2,327	728
August	38,579	1,864	323
September	32,034	1,992	429
October	39,687	1,685	628
November	33,708	2,174	436
December	42,097	3,105	—
January, 1931	27,306	—	—
February	38,370	—	—

AUSTRALASIAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	4,640	5,840	4,824	6,499
Blackwater (N.Z.)	2,965	5,023	3,908	6,597
Boulder Persev'ce (W.A.)	6,261	12,012	6,412	13,880
Grt. Boulder Pro. (W.A.)	9,003	20,846	9,412	21,708
Lake View & Star (W.A.)	12,855	30,324‡	9,629	21,926
Sons of Gwalia (W.A.)	11,380	14,349	11,606	14,823
South Kalgurli (W.A.)	6,835	13,498	7,991	13,806
Waihi (N.Z.)	21,411	{ 7,395* 40,892†	—	{ — —

* Oz. gold. † Oz. silver. ‡ December and January.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	January.		February.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,600	2,105	3,100	2,089
Champion Reef	8,300	5,555	7,560	5,181
Mysore	17,255	11,297	16,492	9,526
Nundydroog	12,013	7,221	11,800	7,029
Ooregum	10,500	5,145	11,026	4,246

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	January.		December.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,410	14,033	—	—
Frontino & Bolivia (C'bia)	2,600	10,267	2,340	13,472
Marmajito (Colombia)	1,120	5,698	950	4,560
Fresnillo	90,286	10,062*d*	—	—
Oriental Cons. (Korea)	17,257	87,408*d*	15,281	77,000*d*
St. John del Rey (Brazil)	—	47,500	—	41,000
Santa Gertrudis (Mexico)	44,478	55,413*d*	—	—

d Dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

July, 1930	5,525	January, 1931	5,450
August	4,153	February	—
September	4,048	March	—
October	4,807	April	—
November	4,812	May	—
December	5,019	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Dec.	Jan.	Feb.
Ayer Hitam	119	131	142⅔
Batu Caves	—	22	16½
Changkat	60	53	67
Gopeng	65½	71½	73
Hongkong Tin	62	53½	56
Idris Hydraulic	38	28	32⅔
Ipoh	56½	55½	33½
Kampar Malaya	93	87	49
Kampong Lanjut	75	55	52
Kent (F.M.S.)	44½	29	21
Kinta	33	30	30
Kinta Kellas	74½	59½	81½
Kuala Kampar	75	65	95
Kundang	—	35	—
Lahat	20½	20½	19½
Malaya Consolidated	37½	55	48½
Malayan Tin	154½	148¾	144½
Pahang	255	256	255⅔
Penawat	58½	73½	53½
Pengkalen	66	77½	63
Petaling	145	184½	195
Rahman	59½	53½	59½
Rambutan	7½	9½	11
Rantau	46	30	21
Rawang	65	65	56
Rawang Concessions	30	35	50
Renong	66	63½	47½
Southern Malayan	223½	199½	170½
Southern Perak	38⅔	37½	50¾
Southern Tronoh	34⅛	45	40
Sungei Besi	39	42	47
Sungei Kinta	13⅔	24	23½
Sungei Way	113	119	107½
Taiping	28	18	14⅔
Tanjong	—	45	51
Teja Malaya	18¼	29¾	22½
Tekka	28	50½	63½
Tekka-Taiping	32	60	56
Temoh	46½	57	46¾
Tronoh	65⅔	90	83

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Dec.	Jan.	Feb.
Amari	5	4½	—
Anglo-Nigerian	40⅔	61	64
Associated Tin Mines	200	250	205
Baba River	7	7	7
Batura Monguna	3¾	4½	3¾
Bisichi	40	50	44
Daffo	12	10⅔	—
Filani	4½	4½	—
Jantar	22	22	22
Jos	24½	24	—
Juga Valley	17	8	6½
Kaduna Syndicate	13	19	—
Kaduna Prospectors	10	11	—
Kassa	9½	11	9
London Tin	80	80	140
Lower Bisichi	6½	8	—
Naraguta	23	17½	—
Naraguta Durumi	10½	—	—
Naraguta Extended	20	10	12
Naraguta Karama	26	20	—
Naraguta Korot	12½	8¾	—
Nigerian Consolidated	14	14	14
Offin River	5	6	5½
Ribon Valley	8½	11	9
South Bukeru Areas	12	12	—
Tin Fields	4	6½	—
Tin Properties	1¼	—	—
United Tin Areas	19	23	18
Yarde Kerri	12	11	11

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Dec.	Jan.	Feb.
Anglo-Burma (Burma)	25	20⅔	14
Aramayo Mines (Bolivia)	245	285	269
Bangrin (Siam)	59½	79	69½
Consolidated Tin Mines (Burma)	113	120	120
East Pool (Cornwall)	37½	41⅓	—
Fabulosa (Bolivia)	140	120	90
Geevor (Cornwall)	—	41⅓	—
Kagera (Uganda)	28	28	16
Malaysiam Tin	23⅞	23⅝	24½
Patino	1,330	1,413	—
San Finx (Spain)	29*	30*	—
Siamese Tin (Siam)	139½	148½	175½
Tavoy Tin (Burma)	78⅜	60	49¾
Tongkah Harbour (Siam)	54	29	32
Toyo (Japan)	89½	80½	72½
Zaaiplaats	24½	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Jan.	Feb.
Broken Hill South	Tons lead conc.	4,370	—
	Tons zinc conc.	—	—
Burma Corporation	Tons refined lead	6,420	6,420
	Oz. refined silver	540,000	530,000
Electrolytic Zinc	Tons zinc	8,299*	—
Indian Copper	Tons copper	359	350
Messina	Tons copper	766	669
Mount Lyell	Tons concentrates	3,530	3,097
North Broken Hill	Tons lead conc.	2,650	—
	Tons zinc conc.	—	—
Poderosa	Tons copper ore	392	392
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,254	1,233
San Francisco Mexico	Tons lead conc.	4,195	3,315
	Tons zinc conc.	4,705	3,458
Tetiuhe	Tons lead conc.	651	925
	Tons zinc conc.	1,685	1,976
Trepca	Tons lead conc.	3,190	3,496
	Tons zinc conc.	2,597	2,404
Zinc Corporation	Tons lead conc.	4,899	—
	Tons zinc conc.	3,437	—

* Eight weeks to Feb. 4.

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

		December.	January.
Iron Ore	Tons	233,780	206,755
Manganese Ore	Tons	19,275	9,152
Iron and Steel	Tons	283,038	221,773
Copper and Iron Pyrites	Tons	20,575	31,474
Copper Ore, Matte, and Prec.	Tons	2,879	1,530
Copper Metal	Tons	13,906	13,706
Tin Concentrate	Tons	5,853	6,276
Tin Metal	Tons	600	590
Lead Pig and Sheet	Tons	25,745	22,591
Zinc (Spelter)	Tons	9,672	10,111
Zinc Sheets, etc.	Tons	2,121	2,656
Aluminium	Tons	1,380	404
Mercury	Lb.	134,176	18,450
Zinc Oxide	Tons	3,652	670
White Lead	Cwt.	12,857	10,932
Red and Orange Lead	Cwt.	4,572	2,112
Barytes, ground	Cwt.	37,906	35,946
Asbestos	Tons	2,448	2,330
Boron Minerals	Tons	732	601
Borax	Cwt.	23,535	20,626
Basic Slag	Tons	3,014	3,773
Superphosphates	Tons	7,965	10,903
Phosphate of Lime	Tons	30,413	20,058
Mica	Tons	187	240
Sulphur	Tons	5,370	4,082
Nitrate of Soda	Cwt.	127,660	118,192
Potash Salts	Cwt.	169,908	198,225
Petroleum: Crude	Gallons	41,187,447	32,112,797
Lamp Oil	Gallons	16,009,101	32,303,540
Motor Spirit	Gallons	52,621,660	78,617,991
Lubricating Oil	Gallons	8,498,232	7,399,204
Gas Oil	Gallons	7,644,814	5,704,855
Fuel Oil	Gallons	44,779,714	48,002,195
Asphalt and Bitumen	Tons	11,372	15,137
Paraffin Wax	Cwt.	109,252	122,010
Turpentine	Cwt.	91,123	44,254

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	December.	January.	February.
Anglo-Ecuadorian	17,339	17,040	14,890
Apex Trinidad	37,280	40,060	36,900
Attock	1,680	1,081	1,492
British Burmah	4,648	4,614	—
British Controlled	35,074	36,073	31,721
Kern Mex	894	785	725
Kern River (Cal.)	1,541	1,482	1,496
Kern Romana	2,182	1,822	1,431
Kern Trinidad	4,494	5,457	5,322
Lobitos	28,401	26,605	23,662
Phœnix	70,523	62,149	52,219
St. Helen's Petroleum	6,243	6,003	5,228
Steaua Romana	91,250	88,950	80,790
Tampico	3,171	3,187	2,789
Tocuyo	2,293	2,382	—
Trinidad Leaseholds	24,400	23,550	20,000

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Feb. 10, 1931.			Mar. 10, 1931.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		11	0		9	0
Anglo-Egyptian B.	2	3	9	2	4	3
Anglo-Persian 1st Pref.	1	7	0	1	5	9
,, ,, Ord.	2	15	0	2	3	9
Apex Trinidad (5s.)		11	0		10	3
Attock		17	6		16	3
British Burmah (8s.)		4	0		4	0
British Controlled ($5)		1	3		1	3
Burmah Oil	3	11	3	3	3	9
Kern River Cal. (10s.)		3	0		2	6
Lobitos, Peru	1	8	0	1	5	0
Mexican Eagle, Ord. (4 pesos)		10	6		9	0
,, ,, 8% Pref. (4 pesos)		10	6		9	6
Phœnix, Roumanian		7	6		6	6
Royal Dutch (100 fl.)	26	5	0	23	12	6
Shell Transport, Ord.	3	16	3	3	5	6
,, ,, 5% Pref. (£10)	10	2	6	10	2	6
Steaua Romana		5	6		4	3
Trinidad Leaseholds	1	6	6	1	2	0
United British of Trinidad (6s. 8d.)		5	6		5	6
V.O.C. Holding	1	13	0	1	13	9

PRICES OF CHEMICALS. Mar. 10.

These quotations are not absolute; they vary according to quantities required and contracts running.

		£	s.	d.
Acetic Acid, 40%	per cwt.		18	9
,, 80%	,,	1	16	3
,, Glacial	per ton	58	0	0
Alum	,,	8	10	0
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.			11
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	9	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			11
,, Sulphide, crimson	,,		1	4
Arsenic, White	per ton	18	17	6
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	9	0	0
,, Sulphate, 94%	,,	6	15	0
Benzol, standard motor	per gal.		1	4½
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	,,	13	10	0
Boric Acid	,,	22	0	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		1	2
,, ,, crystallized, 40°	per lb.			5½
Carbon Disulphide	per ton	16	10	0
Citric Acid	per lb.		1	1
Copper Sulphate	per ton	20	10	0
Creosote Oil (f.o.b. in Bulk)	,,			4½
Cresylic Acid, 98–100%	per gal.		1	8
Hydrofluoric Acid	per lb.			6
Iodine	per oz.		1	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	2	6
Lead, Acetate, white	,,	34	0	0
,, Nitrate (ton lots)	,,	29	10	0
,, Oxide, Litharge	,,	29	10	0
,, White	,,	38	0	0
Lime, Acetate, brown	,,	7	5	0
,, ,, grey, 80%	,,	13	0	0
Magnesite, Calcined	,,	9	10	0
Magnesium, Chloride	,,	5	10	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit 64° Industrial	per gal.		1	9
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	1	12	0
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	,,	42	10	0
Potassium Bichromate	per lb.			4½
,, Carbonate, 96/98%	per ton	25	0	0
,, Chlorate	,,	27	10	0
,, Chloride 80%	,,	9	5	0
,, Ethyl Xanthate	per 1,016 kilos	55	15	0
,, Hydrate (Caustic) 88/90%	per ton	28	10	0
,, Nitrate	,,	19	17	6
,, Permanganate	per lb.			5¾
,, Prussiate, Yellow	,,			6¾
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	10	10	0
Sodium Acetate	,,	17	10	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	26	5	0
,, Cyanide 100% NaCN basis	per lb			7
,, Ethyl Xanthate	per 1,016 kilos	53	5	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	10	0	0
,, Phosphate, comml.	,,	10	0	0
,, Prussiate	per lb.			4½
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	3	0	0
,, ,, (Salt-Cake)	,,	2	15	0
,, Sulphide Conc., 60/65%	,,	9	0	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	10	0
Sulphuric Acid, 168° Tw.	,,	4	12	0
,, ,, free from Arsenic, 144° Tw.	,,	3	15	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.			11½
Turpentine	per ton	40	0	0
Tin Crystals	per lb.			11¾
Titanous Chloride	,,			10
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	37	0	0
Zinc Sulphate	,,	8	5	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Feb. 10, 1931. £ s. d.	Mar. 10, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	3 2 2	2 18 9
City Deep	4 6	5 0
Consolidated Main Reef	1 3 0	1 3 3
Crown Mines (10s.)	4 1 0	4 3 9
Daggafontein	1 13 9	2 0 0
Durban Roodepoort Deep (10s.)	14 0	14 9
East Geduld	2 9 0	2 12 6
East Rand Proprietary (10s.)	10 3	10 3
Geduld	3 17 6	3 18 0
Geldhenbuis Deep	8 0	8 0
Glynn's Lydenburg	3 9	3 9
Government Gold Mining Areas (5s.)	1 12 6	1 12 0
Langlaagte Estate	1 5 6	1 5 3
Meyer & Charlton	15 0	16 3
Modderfontein New (10s.)	3 3 0	3 6 3
Modderfontein B (5s.)	11 6	9 6
Modderfontein Deep (5s.)	1 1 3	1 2 6
Modderfontein East	1 8 9	1 8 0
New State Areas	2 2 0	2 3 0
Nourse	11 9	12 9
Randfontein	17 3	1 0 0
Robinson Deep A (1s.)	16 3	15 0
" B (7s. 6d.)	11 9	10 9
Rose Deep	6 0	6 3
Simmer & Jack (2s. 6d.)	3 3	3 0
Springs	3 2 6	3 4 0
Sub Nigel (10s.)	3 3 0	3 1 0
Van Ryn	7 9	7 6
Van Ryn Deep	1 6 3	1 6 3
Village Deep (14s.)	5 9	6 3
West Rand Consolidated (10s.)	9 6	10 0
West Springs	11 6	12 6
Witwatersrand (Knight's)	11 0	10 6
Witwatersrand Deep	3 9	4 3
RHODESIA:		
Cam and Motor	14 3	1 0 0
Gaika	3 6	3 6
Globe and Phœnix (5s.)	15 0	14 0
Lonely Reef	16 3	15 0
Mayfair	7 6	7 6
Rezende	1 5 0	1 0 0
Shamva	1 0	1 0
Sherwood Starr (5s.)	13 0	13 9
GOLD COAST:		
Ashanti (4s.)	2 7 6	1 8 0
Taquah and Abosso (5s.)	4 3	4 6
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 0	2 0
Great Boulder Propriet'y (2s.), W.A.	1 3	1 3
Lake View and Star (4s.), W.A.	9 6	10 6
Sons of Gwalia, W.A.	3 6	4 0
South Kalgurli (10s.), W.A.	11 6	11 6
Waihi (5s.), N.Z.	13 0	14 0
Wiluna Gold, W.A.	16 0	18 6
INDIA:		
Balaghat (10s.)	2 0	2 0
Champion Reef (10s.)	8 6	8 0
Mysore (10s.)	11 0	10 6
Nundydroog (10s.)	17 9	17 0
Ooregum (10s.)	3 6	3 0
AMERICA:		
Camp Bird (2s.), Colorado	6	6
Exploration (10s.)	3 6	3 0
Frontino and Bolivia, Colombia	8 9	8 9
Mexican Corporation, Mexico (10s.)	3 3	4 9
Mexico Mines of El Oro, Mexico	2 0	2 0
Panama Corporation	16 3	17 6
St. John del Rey, Brazil	19 6	1 0 6
Santa Gertrudis, Mexico	7 6	7 9
Selukwe (2s. 6d.), British Columbia	3 0	3 0
MISCELLANEOUS:		
Chosen, Korea	3 9	4 3
Lena Goldfields, Russia	6	6
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	5 6	6 3
Esperanza Copper	14 3	13 9
Indian (2s.)	1 3	1 6
Loangwa (5s.), Rhodesia	2 0	2 0
Luiri (5s.), Rhodesia	3 0	3 0
Messina (5s.), Transvaal	10 6	11 6
Mount Lyell, Tasmania	17 6	17 6
Namaqua (£2), Cape Province	5 0	5 0
N'Changa, Rhodesia	1 15 0	1 15 0
Rhodesia-Katanga	17 6	17 6
Rio Tinto (£5), Spain	30 5 0	28 5 0
Roan Antelope (5s.), Rhodesia	16 3	17 0
Tanganyika Con.	1 13 0	1 12 0
Tharsis (£2), Spain	3 17 6	3 15 0

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

MINING ON THE WITWATERSRAND

At a meeting of the Institution of Civil Engineers held on February 10 last, a lecture was given by Mr. James Whitehouse on "Some Methods of Gold-Mining." Extracts from his paper, which gives a short description of methods used in gold-mining in the mines of the Witwatersrand, are given here.

The author states that the sinking of vertical shafts to great depths has been general on this field during recent years. The type adopted has varied according to conditions and requirements, various rectangular sections having been used, whilst a number of circular shafts have been sunk. Where ore-raising capacity has been of primary importance, the rectangular type has in some instances been adopted in a variety of shapes. Where sinking to depths of 6,000 to 7,000 ft. has been undertaken, however, circular shafts have been put down. The most important consideration in deciding the type of shaft in the latter case is the exclusion of moisture. When air which may be comparatively dry is passed down a deep shaft, the relative humidity is raised very considerably, and the cooling-power is correspondingly reduced. In timbered rectangular shafts the air is exposed to shaft moisture which cannot be effectively excluded, whereas in lined circular shafts any water met with can be collected and piped away. Hence the circular shaft has a great advantage over other types where sinking is being carried to great depths. In good ground the sinking of about 300 ft. below the last walling is usual before stopping to line the shaft, and rapid progress is made.

In lining shafts the use of curbs is now generally dispensed with, and concrete rings are used for supporting each length of shaft-lining as it is built. Holes are drilled round the shaft a few feet above the bottom, and into them are driven steel plugs which project into the concrete ring, which is built over them by the use of a special former. This method saves time and facilitates the completion of the next length of lining below.

The equipment of circular shafts exceeding 3,000 ft. in depth—which is considered the limit of rope guides—may provide for the use of one or two hoists, and compartments are arranged to suit requirements. Generally one large hoist is installed which operates two large cages, and a pair of cages or skips are operated by a second one. Buntons are so arranged that the shafts are left as free as possible to facilitate the lowering of heavy machinery and the passage of air. The adoption of one large and one small hoist provides security in case of winding accidents, and relieves the large hoist of odd journeys for the purpose of lowering small loads. Such an arrangement was made at the Crown mines No. 16 shaft. The finished diameter of the shaft is 20 ft. 6 in. The buntons, which are kept to the sides of the shaft, provide for two big cages and two smaller ones.

Another arrangement is that adopted for the City Deep mine, where one hoist only operates. The cages run in rail guides and are capable of raising 110 persons per trip from a depth of 4,500 ft. In this case sinking was carried to a depth of 7,000 ft. from the surface in two stages; the first shaft is 4,500 ft. deep, and from the bottom of this a second one was sunk a further 2,500 ft. Concrete rings, spaced at intervals of 10 ft., and having a section 18 in. by 15 in. wide, were used as support in the upper shaft for the first 3,000 ft., and walling was used below this point. The lower shaft was walled throughout with concrete blocks shaped to the radius of the shaft.

In considering the hoisting-ropes for the 4,500-ft. wind, the choice lay between the lock-coil, ordinary lay, and flattened strand types. The disadvantages of lock-coil ropes are weight, lack of flexibility, internal corrosion, and the difficulty in drawing the sections of the wire in high-tensile steel. Ordinary lay rope has the advantage of being practically non-spin and consequently gives the least wear on the rail-guides in the shaft. The inability to get a large enough cross-sectional area to give the requisite breaking-strength without resorting to a wire central core in place of the usual hemp core, however, necessitated the use of the flattened strand type. Whilst the flattened strand rope has a certain amount of spin in the initial stages, it is found that after a few weeks' use the rope becomes practically non-spin. The increased cross-sectional area of this type of rope gives the breaking-strength called for, namely, 260 tons. The weight is approximately 9 lb. per foot compared with 12 lb. for a lock-coil rope, and a factor of safety of 6·5 is obtained. The aggregate breaking-load of the wires of this rope was 295 tons, and the actual breaking-load on the testing-machine was 260 tons.

The following particulars were supplied to the manufacturers of these ropes: Depth of wind 4,500 ft. vertical; load of rock, 16,000 lb.; weight of truck, 7,000 lb.; weight of cage, 15,000 lb.; winding-speed, 3,600 ft. per minute; acceleration of full truck and cage, 1·8 ft. per second per second; acceleration of empty truck and cage, 3·633 ft. per second per second. These ropes pass over 20-ft. diameter pit-head sheaves; the drums are large, and the conditions generally are good. The cost of each rope, however, is about £1,800, and good conditions are, therefore, essential to economical working.

Centrifugal pumps are generally used for pumping operations, and lifts up to 3,000 ft. are not unusual. The advantage of this type is the large capacity

in relation to the space occupied. For the successful operation of these pumps, however, the water must be free from suspended matter and, to ensure this, settlement-sumps are provided in which solids are removed before the water passes into the storage-sumps. The mud settled is withdrawn from the bottom of these and stored in old workings or sent to the surface. In this way impellers are protected and the capacity of the storage-sumps is maintained.

The development lay-out of the mines provides for the concentration of ore in order to allow it to be handled mechanically. For this purpose ore-chutes are provided which deliver ore to main haulage-levels, along which it is conveyed to the shafts by electric locomotives or other mechanical means. Haulage-levels are driven in the footwall well below the reef in order to avoid the effects of pressure following its removal. For large tonnages, electric traction with overhead wire is generally adopted, whilst storage-battery locomotives are used for moderate tonnages in less permanent places. An example of overhead electric wire haulage is that operating on the 3,000-ft. level at the Crown mines. This haulage-level has a cross-sectional area capable of accommodating a double track of 30-in. gauge and has a height of 9 ft. in order to minimize the risk of accident from contact with the bare copper conductor. Rails weighing 45 lb. per yard are used, and in certain cases these have been replaced by heavier sections. Current is supplied at 500 volts, and standard 8-ton locomotives with a draw-bar pull of 4,000 lb. are employed with 8-ton bottom-discharge cars. The work accomplished by these locomotives is equivalent to 660 ton-miles in 6 hours ; and the cost of haulage on this level for a month's output of 204,646 tons was 3·1d. per ton handled.

Development, which is done in hard quartzite, is accomplished with rock drills of the hammer type of various makes and sizes. The placing of holes is controlled by the use of a " hole-director " which is designed for the size of drive required. In this way accurate placing is obtained and better results are achieved than by relying on the miners' judgment. As a result of this procedure and the improvement in the sharpening and tempering of steel, the advance made per machine-shift has increased by 30% during the last 2 years, and the cost has been reduced by 5s. per foot advanced. This increased efficiency has been attained over an advance of 400,000 feet per annum.

The author has recently dealt [1] with the subject of heat in deep mines, and he did not propose, therefore, to discuss the question again except to point out that in laying out deep mines the question of ventilation must be given very serious consideration. The placing of the main development-drives in the footwall facilitates ventilation in that control is obtained, and in some cases special shafts have been sunk for this purpose. One of these is at the State mines. It is of circular section, 22 ft. in diameter, and lined with mass concrete. It is equipped with a fan of the paddle type, 30 ft. in diameter and 10 ft. wide. It has a capacity of 900,000 cu. ft. of air per minute at a water-gauge pressure of 7 in. Conditions have not yet necessitated the running of this fan at full speed, but a trial at a reduced speed gave the following results :—

Speed	100 r.p.m.
Indicated horse-power of engine	809·5
Air horse-power	565
Over-all efficiency of engine and fan	69·9%
Volume of air per minute	796,000 cu. ft.
Total water-gauge pressure	4·5 in.

Great progress has been made in recent years in the breaking of ground. Before the use of machines for this purpose holes were drilled by hand hammers, which method was largely replaced by the use of heavy reciprocating machines. The results obtained were not entirely satisfactory, particularly in deep mines, since the blasting of a number of large holes drilled on one bench resulted in damage to the hanging wall, and, further, the consumption of explosives was very high. It was realized that, if a satisfactory small machine could be obtained which would drill small holes similar to those put in by hand, economy in explosives would result, whilst a very large economy in labour would be effected compared with hand drilling. These conditions were met by the jack-hammer machine which is now in general use. One of these machines is capable of doing the work formerly accomplished by twenty-five natives.

The tempering of drilling-bits has received great attention in recent years, and this work is now so much improved that two steels—and sometimes one—are now used where formerly four were required. This has resulted in a reduction in the diameter of the holes drilled, and in the reduction in the difference in the gauge between bits to $\frac{1}{8}$ in. The effect of this on drilling-speed will be appreciated, since the smaller the diameter of hole the less the area of rock to be pulverized. The air-pressure used in rock-drills has also been the subject of investigation. With too high a pressure breakages of steel become frequent, and drilling is thereby retarded. Too low a pressure, on the other hand, leads to the blunting of the steel and loss of gauge. The correct pressure for the particular class of rock to be drilled must, therefore, be determined by experiment. For the drilling of quartzite with jack-hammers, this has been found to be 65 lb. per sq. in. The carbon-content of the steel is an important factor in obtaining the best drilling results. Generally 0·75% carbon steel has been found satisfactory, though in some cases steels containing 0·90% of carbon have given good results.

The strength of explosives used depends on the nature of the ground to be broken. A general reduction in the nitro-glycerine content has taken place in recent years, and the average strength now used is 45%. In the last 5 years the quantity of nitro-glycerine used per ton of ore broken has been reduced from 0·497 to 0·369 lb.

The mines of the Witwatersrand crush annually about 29 million tons, and the gold recovered is equal to approximately 28s. per ton or a total of £41,000,000. The ore is crushed by stamps of the Californian type, and in later mills by Nissen stamps, whilst in the more recent plants erected stamps have been eliminated and the ore after passing through the crushers goes direct to tube-mills.

Amalgamation after crushing has been replaced by corduroy concentration, and in the most recent plants crushing takes place in cyanide solution. Cyanide treatment follows crushing operations. In older plants sands and slimes are treated

[1] Inst. C.E. Engineering Conference Report, 1928, part 2, p. 194.

separately, whilst in those recently erected all-sliming treatment has been adopted. Examples of the percentage gradings of the pulp in each of these cases are as follows, Tyler standard screens being employed :—

WHERE SANDS AND SLIMES ARE TREATED SEPARATELY.

	Pulp to Cyanide Works.			*Sand Residue.*			*Slime Residue.*		
	+48	+100	-100	+48	+100	-100 -200	+48	+100	-100 -200
A	1	16	83	4	42	22 32	—	—	3 97
B	1	23	76	2	41	33 24	—	—	5 95
C	2	20	78	6	48	32 14	—	—	13 87

IN AN ALL-SLIMING PLANT.

		%
Final pulp	+ 100	4·4
	+ 200	24·6
	- 200	71·0

The crushing of hard ore to the fineness required to ensure good extraction entails the use of much power, and to this must be added that required for other mining purposes. The power-consumption for a large mine during a year illustrates this point.

Tons milled . . .	2,508,000
Total units consumed . .	137,231,841
Units per ton milled . .	54·7

This power was taken for the following services :—

Winding	11·89
Pumping	6·67
Drilling	3·68
Other underground, including transport	1·13
Ventilation	6·09
Reduction	19·50
Workshops	1·58
Surface general.	1·69
Construction	1·52
Unaccounted for	0·96
	54·71

Power is supplied to most mines by the Victoria Falls Power Company from their large generating stations, transmitted at high voltage and transformed down to 2,000 volts for general use. To supply the heavy power requirements underground for hoisting, pumping and other services, current is now transmitted at 20,000 volts. This results in considerable economy in cables and reduces the number which must be carried down the shafts.

ELECTRO-DEPOSITION OF GOLD

In the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa for October last, E. J. Dunstan describes some experiments on the electro-deposition of gold from alkaline cyanide solutions. He states that the object of the investigation was to determine whether an improvement upon the older methods of electrolytic precipitation of gold from cyanide solutions could be effected by the use of a rotary cathode. The improvements aimed at were :—(1) Higher current efficiency ; (2) more complete precipitation ; and (3) increased rapidity of operation. In addition it was required that the apparatus should not be bulky and be easy to operate.

A stock solution of gold in potassium cyanide was prepared by dissolving pure precipitated gold in potassium cyanide solution of 0·5% strength. It assayed 72·2 oz. gold per ton with a cyanide strength of 0·19% KCN.

The apparatus used was a Sand's rotating electrode electrolytic apparatus adapted to suit the requirements of the experiment. It consisted of a small a.c. motor driving a vertical shaft by means of belt and pulleys. The interior of the shaft was hollow and filled with mercury, into which dipped a stationary rod connected to a terminal making electrical contact between the stationary terminal and the rotating spindle. The lower end of the shaft was closed by a screw clamp attached by rubber pressure tubing. This clamp held a copper rod about 10 in. long, at the lower end of which was a wood mandrel 1 in. diameter and 5 in. long, round which the lead foil used as the cathode was fastened. For steadiness the copper rod was held in two bearings. The rod also carried a sprocket which was geared to a "Veeder" revolution recorder. The gearing was so adjusted that the unit figure of the recorder registered unit revolutions, but this was later altered so that it registered one unit to ten revolutions of the shaft.

The cathode consisted of a layer of lead foil wrapped round the wood mandrel described above and held on by a band of copper wire above the level of the solution. Attempts were made to burn the lead into a cylinder enclosing the wood, but these were not successful.

In the old Siemens-Halske process an iron anode was used, which was converted gradually to Prussian blue, fouling the solution and forming an inconvenient by-product. Acheson graphite has been used in New South Wales, but this slowly disintegrated and hard graphite was tried by A. von Gernet at the old Worcester mine, with the same result. Andreoli used peroxidized sheet lead, which Clevenger also states to be the best material. It was, therefore, decided to use peroxidized lead. At first lead peroxidized by electrolysis in dilute sulphuric acid was employed, but this, even after thorough washing, produced a precipitate in the solutions electrolysed. Lead peroxidized by electrolysis in a permanganate solution was tried and a satisfactory result obtained. After a few trials an anode was made which was used in the greater number of the experiments. The peroxidizing was carried out as follows : a 1% solution of potassium permanganate was used as the electrolyte. The current was adjusted so that the current density was one ampere per sq. ft. After the current had been passing for one hour the lead was sufficiently peroxidized.

Experiments were then carried out in order to ascertain the most suitable method of working the apparatus. A portion (25 cc.) of the stock gold solution was diluted with water, and a 0·01% KCN solution, to about 7 litres. It then assayed 4·4 dwt./ton with cyanide strength of 0·01%. Alkali was added in the form of potassium hydroxide (about 3 grams in stick form), but the amount of "protective alkali" was not determined. A quantity, 300 mls. of this solution, was measured into a beaker which was placed in position in the apparatus and connected in series with an electrical circuit consisting of five Edison cells, a rheostat, ammeter, key, and voltmeter. The last was shunted across the anode and cathode. The motor was started, and when speed had been gained the electrolytic circuit was closed. At the same instant the reading of the revolution counter was taken.

While running, readings of the revolution recorder, current and voltage across the electrodes, were made every minute. At the end of ten minutes the circuit was broken, the motor stopped and the cathode removed, dried, cupelled and the gold weighed. A final reading of the revolution counter was taken as the circuit was broken. In all the experiments the temperatures of the room and of the solution were taken so that any great variation, which would affect the experiment, could be noted. To determine the area of the cathode, upon which deposition of gold took place, the depth at which it was immersed was measured. The experiments were repeated for the following periods: ten minutes, fifteen, twenty and thirty minutes respectively.

According to Allmand and Ellingham ("Applied Electro-Chemistry") the current density employed in the Siemens-Halske process is given as 0·00004 ampere per sq. cm., or 0·000357 ampere per sq. in. The current densities in the above experiments are, therefore, about 240 times as great, as it was hoped thereby to greatly increase the rate of deposition. There was considerable frothing during electrolysis, especially at the cathode. Subsequently it was found that, with a lower current density, only three times as great as that given for the Siemens-Halske process, equally good deposition without the frothing was obtained, for as much gold was deposited in the same time and the deposit was, apparently, as uniform and coherent. In the remainder of the tests the lower current density was therefore used.

It may be noted that the cuprous chloride method of assay for gold in the cyanide solutions was employed at first, but the assay became contaminated with silver from the litharge used, and high results were obtained, unless the beads were inquarted and parted. To avoid this the zinc-lead acetate method of assay was tried and gave concordant results, which agreed more closely with an evaporation assay.

Tests were carried out on successive separate quantities of the electrolyte and then others were made with the solution flowing through the cell. A gold cyanide solution assaying 4 dwt./ton was made up from stock and used for this purpose.

The results of the experiments and the conclusions drawn are summarized as follows:—

(1) No evidence of regeneration of cyanide by electrolysis of a working cyanide solution was found, there being, on the contrary, a further loss during electrolysis.

(2) The use of a rotating cathode does not materially increase the current efficiency, which is extremely low, due to the dilute solutions employed.

3) The degree of precipitation, as compared with the modern methods of zinc precipitation as used upon the Reef, cannot be economically improved upon by electrolytic methods.

(4) It is also doubtful, in consideration of the fact that the solution required passing through the cell four times, whether there would be any saving in space and power.

(5) The rotating cathode has a depolarizing effect, probably due to the friction of the solution keeping the surface free from bubbles of gas, which enables a lower voltage and higher current density to be employed. Owing to the negative results obtained with regard to the current efficiency this effect was not investigated further.

In view of these considerations the objects set out at the commencement of this paper were not attained, and the investigation was concluded.

BORE-HOLE SAMPLING

The *Bulletin* of the Institution of Mining and Metallurgy for February contains a paper by D. K. F. MacLachlan describing the practice of sampling and estimation of bore-hole cores and sludges, as carried out on certain mines in Northern Rhodesia. Full extracts from the paper are given here. The author's description, which contains special reference to the Roan Antelope copper mine, covers the methods developed by some of the mines in the copper belt in an attempt to solve the problems involved.

Continuing, the author says the greatest care must be taken with the technique of the drilling and sampling in order to ensure accurate results. Estimations of values from core results only may in some cases be seriously misleading, their reliability depending on the percentage recovery. Where the core recovery is over 90%, the results may be accepted as being fairly reliable, but this high recovery is not always obtainable, and the missing portion of the core, which is represented by sludge, must be taken into account. All efforts in sampling should therefore be directed to obtaining as high a recovery of core as possible and the correct corresponding quantity of sludges with their correct metallic contents.

Preparations for sampling should be, if possible, completed before the ore-body is struck. A competent sampler should be on the spot to watch the cores carefully, as occasionally an inexperienced drillman penetrates the ore-body without being aware of the fact. A strict watch should be kept for any tendency of the bore-hole to deflect excessively, particularly when approaching the ore-body, as, especially with shot drills, deflection may cause the core-barrel and rods so to abrade the country rock as seriously to dilute the sludges. If the deflection is gradual, so that casing may be inserted down to the top of the ore-body, the consequences are usually not very serious. When drilling, therefore, the hole should be carefully watched and surveyed whenever deflection is suspected. A really serious deflection soon makes its presence felt by the continual breaking of rods at that particular point.

There are so many factors affecting deflection and their action is so imperfectly understood that it is very difficult to keep a hole straight once a bend has started. As a general rule, it will be found that the most careful and experienced operators will put down the straightest holes. The practice of "forcing" the bit is sure to cause deflection. Experiments have shown that in the case of shot drills, the deflection varies inversely as the square of the length of the core-barrel. As a general rule, shot drills deflect more than diamond drills, owing, possibly, to the action of the former being due to abrasion and the latter to cutting. In passing, it is worthy of note that the under surface of a core taken from an inclined shot drill hole is much smoother than the upper, which is usually more or less scored and grooved by the action of the shot. This characteristic is sometimes very useful, as it enables the engineer,

if the dip and direction of the hole are known, to obtain at least a rough idea of the dip and strike of the rock penetrated.

The most common method of straightening a hole is to cement up to a little above where the bend first becomes noticeable, preferably with a rapid hardening cement, and then to re-drill, applying as little pressure to the bit as possible. When drilling with shot, in an attempt to straighten the hole, it is sometimes a good plan to feed the shot to the outside of the bit. Straightening by cementing and re-drilling will usually show some improvement, but only in very rare cases will the hole be rendered absolutely straight. Straightening the hole by means of wedges is occasionally, attempted, but this method is difficult to apply and takes considerable time. In some cases, especially where the hole is deflecting with the strata and the depth is not too great, it will possibly be found best to abandon the hole and to start another one near by. It is advisable to use as large sized bits as possible, not only because the larger size of hole makes it easier to introduce casing past a bad deflection, but also in order to have a reserve string or two of casing in hand when the ore-body is struck, so that any bad ground encountered therein may be cased off. Large bits have the disadvantage of being slower and, in the case of diamond drills, more expensive on carbon than the smaller sizes, but other considerations over-ride these.

When the drill is approaching ore, the sampler takes charge, and he should be supplied with the following equipment :—

(1) Cement.—This should be rapid-hardening if possible.

(2) Soap.—Ordinary soft soap is all that is required.

(3) Sludge Tanks.—These are described later.

(4) Log Book.—This should be printed in duplicate, and space should be provided in it for all necessary data.

(5) Lock-fast Box.—To hold apparatus and reagents for testing sludges.

(6) Long metal Tapes.—These may be obtained in various lengths to suit the different depths of hole requiring to be measured. As the core, especially in shot drills, sometimes projects a little above the actual bottom of the hole, this measurement is necessary. The actual depth of the distance drilled is measured by the rods, and care is taken, after the next pull, to add the projecting piece of core to the previous core sample in order to make both core and sludges representative of the same part of the ore-body.

(7) Core-boxes.—These may be of various patterns, but should be provided with hinged lids, hasps and staples.

(8) Chalk or Crayons.—For marking horizons on cores.

(9) Micrometer and Callipers.—Required for the measurement of external and internal diameters of bits. In the smaller sizes of bits it is necessary to measure with great accuracy as any deviation from the correct diameters is reflected in the accuracy of the percentage recovery in the final calculations.

(10) Watch with second-hand.—For timing velocities, etc.

(11) 1,000 cu. in. Box.—Used for the measurement of the rate of flow of the discharge water, and is best made of galvanized iron.

(12) Quantity of Alum.—Required for the settling of the sludges.

(13) A few galvanized iron containers.—For collecting and transporting sludges to drying baths. These are best made shallow.

(14) Sample Bags and Tickets.—The raising of the exact amount of sludge made by the drill bit, together with its correct metallic content, is the most difficult operation in drill-sampling and the problems involved are not yet completely solved.

The major difficulties to be overcome are as follows :—

(1) To prevent the sludges being absorbed by the country.

(2) To prevent dilution from the walls of the hole above the run to be sampled.

(3) To ensure sufficient velocity of the return water in the hole to raise the heaviest contents of the sludges.

(4) To prevent the natural tendency of any sulphides in the sludges to adhere to the surface of the rods and casing.

These difficulties will now be dealt with seriatim.

(1) *To prevent the sludges being absorbed by the country.*—The sampler stationed at the drill should be capable of making rough qualitative tests for the minerals being drilled for and should be provided with the necessary apparatus and reagents. When the appearance of the core indicates that the ore-body has been, or is about to be struck, drilling should be suspended, and, if the diameter of the hole allows, it should be cased. The hole should always be thoroughly cleaned out before inserting the casing, which in some cases it is advisable to seal off at the bottom with cement in order to prevent the escape of the sludges round the outside, although this makes the recovery of the casing more difficult. Before cementing, the possibility of having to pull the casing for the purpose of reaming at a later stage of the operations should be considered. Latterly, so much importance has not been attached to cement sealing as formerly, the weight of the casing being considered sufficient to prevent any leakage of the sludges.

After casing, the hole should again be thoroughly pumped out, not only to get rid of any material which may have come down from above during the operation of casing, but also to ascertain whether all the water is coming back. The depth of the hole should then be measured with the long line and the length of the rods checked. The length of the hole drilled in each run before core is pulled depends upon the nature of the ground encountered, and can only be determined by local experience. Towards the walls of the ore-body, short pulls of from 2 to 5 ft. should be taken in order to arrive at a more accurate determination of the " cut-off " or position of the limit of payability. After that has been ascertained, the practice on the Roan Antelope mine is, when the ground stands up well, to use the double-tube core-barrel and drill until " blocking " takes place or until the barrel is full.

A close watch is kept on the return water and when this fails, owing to the cutting of underground fissures or absorbent ground, the drill is stopped and measures taken to caulk the leak. The most obvious way of doing this is to pull the casing, ream, and then re-insert the casing to the bottom of the hole, but this method has the disadvantage of being expensive on carbon and also of occasionally running off or " losing " the hole. In some cases, however, where the ground is soft, the casing easily pulled, and the amount of reaming to be done not large, it will be found to be most efficacious and positive. If reaming down and re-inserting casing is not deemed to be advisable, then other means, such as

cementing, have to be adopted. A rapid-hardening cement should be used, and care should be taken to ensure that it reaches the bottom of the hole before the time of its initial set. When the cement is inserted in the hole, a little cement should be mixed in water and kept in a cigarette-tin lid or similar receptacle. This serves as a "control" to indicate whether the cement in the hole has reached the bottom before setting. When the flattened point of an ordinary lead pencil held vertically and allowed to rest lightly on the "control" is unable to penctrate the surface, the cement may be said to have set. In no circumstances should the cement be simply poured into the hole and allowed to settle freely, the general practice being to insert it enclosed in paper bags or cartridges and to tramp it in with a casing plug or similar tool attached to the end of the rods. Occasionally, underground water channels are struck, and then cementation in the ordinary way presents extraordinary difficulties and other methods have to be devised. A cartridge of paper, about 2 ft. long, the bottom half filled with dried grass and the top half with cement, and lead wool proving successful. Other materials useful for sealing off small leaks into the country are bran, grain husks or horse manure. Mud is also sometimes used. When drilling, as little water should be used as possible, in order that the rising velocity of the return water should be kept sufficiently low to allow the heavier contents of the sludges to remain as close as possible to the bottom of the hole, as the less area of surface they are in contact with, the better.

(2) *To prevent dilution from the walls of the hole above the run to be sampled.*—Dilution from above is usually due to any of the following three causes :—

(*a*) Abrasion by the rods and core-barrel of the under side of the hole through it not being vertical and the resulting sludges becoming mixed with the sludges proper. The only way of overcoming this, once the hole has gone off the vertical, is to keep the casing down as far as possible.

(*b*) The presence of soft or broken ground in the uncased portion of the hole. The only satisfactory way of dealing with this difficulty is to case off the weak parts. This sometimes entails reaming, which is always expensive, and, if that is not practicable, means that the hole has to be reduced in size. Filling up with sand to just below the poor parts and then cementing them off and re-drilling seldom meets with success, but may be worth a trial.

(*c*) Failure to raise all the sludges from the previous run. This usually results in salting the sample from the next pull, as the tendency is for the heavier and more valuable contents to be left behind.

(3) *To secure sufficient velocity of the return water to raise the heaviest contents of the sludges.*—This is the most important operation in sludge sampling. Unless the utmost care and vigilance is spent on ensuring success in this direction, the trouble and expense incurred in guarding against other adverse circumstances is wasted. When the question first came up for consideration on the Roan Antelope mines, only short drills were in operation and the methods adopted referred to that type only, but the technique eventually evolved applies to both shot and diamond drills. It was decided that, if sufficient velocity of the return water could be obtained to raise the steel shot used in drilling, that would be satisfactory evidence that the heavier contents of the sludges were also being recovered.

From practical experiments in the laboratory, checked later by Rittinger's formula, it was found that the rising velocity necessary to keep the steel shot in suspension was 18 in. per second. This then became the lowest velocity allowable, but, of course, the higher the velocity above that limit, the better.

Broadly, the practice used to be to pump as great a volume as possible down the rods, using a 20 ft. core-barrel, the upper 10 ft. of which was open at the top and plugged at the bottom, thus forming a 10 ft. "sediment tube," the intention being to recover the lighter sludges from the return water which rose between the casing and the rods and the heavier sludges from the sediment tube. This method was erratic and unreliable. As it was suspected that the poor results could be attributed to the friction between the core-barrel and the walls of the hole, a 4 ft. core-barrel, known as a "scrubber" was tried out. The upper 2 ft. of this scrubber was sediment tube, and with it excellent results were obtained, all the shot, and by inference all the heavier contents of the sludges, being recovered. This scrubber was always put down and the pumps worked under full pressure after the hole had been pumped out in the ordinary way, using a 20 ft. core barrel. But this method occasioned much loss of time, and after experiment it was finally found that a 10 ft. core-barrel, the upper half of which was sediment tube, served excellently for the dual purpose of drilling in the ore-body and scrubbing. As, while drilling in the ore-body with the shot drill, the longest permissible pull is about 4 ft. owing to the core not being protected by a double tube, the use of the short 10 ft. barrel is not a disadvantage. When diamond drills appeared on the property the methods described above could not be applied. After some experiment, it was decided to attempt "reverse pumping," in other words, to pump down between the rods and casing, the water and sludges returning up through the rods. With this method, after core is pulled, the core-barrel is detached and the rods lowered to near the bottom of the hole. A gland at the surface, sealing the space between the rods and the casing, is then tightened up and the current reversed The discharge of the pump is connected to the casing by a T-piece and suitable fitting, the return water and sludges being led from the top of the rods by a flexible hose to the sludge tanks.

On the first introduction of this system, a ball-valve was attached to the lower end of the rods, the object being to prevent any slipping back of sludges, but it was found later that not only was this not necessary, but that the ball tended to jam occasionally, thus defeating its own object. After pumping has started, the rods are gradually lowered until they are about 1 or 2 in. off the bottom of the hole, and pumping continued until tests of the sediment from the clear water issuing from the hole shows no material to be present. By reverse pumping, velocities as high as 18 in. per second have been obtained.

Not only does this method recover the highest percentage of sludges and metallic contents, but it also has the advantage that owing to the shorter duration of pumping, a less total volume of water is required and therefore fewer settling tanks are necessary. There is also the advantage that the sludges are less in contact with the casing or walls

of the hole, and less risk is run of loss from that cause. A considerable saving in time is also effected, averaging about one hour per run.

(4) *To prevent the natural tendency of any sulphides in the sludges to adhere to the surface of the rods and casing.*—When the grease from the rods and casing, after being in contact with copper-laden sludges, was assayed, it was found that although that from the shot drills gave only a negligible reaction, the grease from the diamond drills contained an appreciable quantity of copper in the form of sulphides. To avert this loss, the inside of the casing and the inside and outside of the rods are thoroughly cleaned with paraffin or petrol before drilling in the ore-body. Soapy water is used as a lubricant while drilling, being taken from a container by means of a pipe of small diameter attached to the pump suction. It will be noted that, with reverse pumping, the greasy area tending to catch the valuable sulphides is much less than that exposed by the old method.

Settling tanks were formerly of wood, rectangular in shape, and roughly 10 ft. long by 3 ft. wide by 18 in. deep. This form of tank was open to several very grave objections, and it was found that the disadvantages were obviated by making the tanks of galvanized iron, of much the same section as a " U ", the same dimensions being adhered to. The tanks were mounted on a wooden framework, made as light as possible compatible with strength, in order to facilitate moving. The tanks were connected in series of aprons or pipes, and, although they solved leakage and cleaning problems, it was still found impossible to prevent an appreciable amount of sludge from passing away by the over-flow, despite the use of lime and alum for rapid settling, baffle plates, and the prevention of eddies and undue disturbances at the points of intake. The solution of the problem was to remove the connecting pipes or aprons and fill the tanks independently by a launder. When one tank was filled, the sludges were switched to the next, and so on, instead of passing from the first tank down the series to the overflow.

When using this procedure, the tanks are still kept in two rows of five, and *all* the sludges are saved. If five tanks are filled before the return water is free from copper, two or three of the tanks in the second row are filled. As these only catch the heaviest particles which come up towards the last stages of the pumping, their contents are quickly settled, and very little time is necessary before they can be cleaned out and ready for the next run, while the thicker sludges in the first row of tanks are settling. These are usually left over-night in order to settle completely, after which the clear water is decanted by a syphon and float.

On some mines in Northern Rhodesia, the tanks are arranged in a fan-shaped formation instead of in two parallel rows. If ant-heaps, large trees and drilling gear admit of it, there is very little to choose between the two arrangements, although the writer prefers the latter.

The launder feeding the tanks is best made of galvanized iron, and care should be taken to clear it out thoroughly after each run, or else there is every probability that some of the valuable heavier contents of the sludges will be lost.

Various methods are employed in order to settle the sludges in the tanks, such as adding lime in solution, sprinkling with lime or wood ashes and adding alum. Alum takes longer than lime or ashes, but has the advantage of leaving the decantant much clearer, and also of not adding appreciably to the weight of the sludges—less than a handful of alum is sufficient to settle the sludges from the average run. Sodium silicate has also been tried, but was not a success.

When the clear water in the tanks has been decanted off, the precipitated sludges are collected and dried out by boiling them down in ordinary galvanized iron baths over a slow fire. After drying, the sludges are bagged and sent to the crusher-house, where the usual routine is observed as much as possible of the work being done mechanically.

The method of dealing with cores is as follows. After arrival at the core-house, and before being split, the core intended for a separate sample is carefully measured, the average diameter being taken with a micrometer to 0·01 in. in diamond-drill cores and $\frac{1}{32}$ in. in shot drill cores. The weight, angle of intersection of the bedding planes (if any), and density is also ascertained, and general notes are taken of the mineralization, etc. One half of the core is then crushed and a sample of the pulp sent to the assayers, the other half being retained for record. Whenever the data required are available, they are at once entered in the schedules kept for the purpose in the calculating-room.

Calculations of Bore-hole Values.—This part of the paper, dealing with the calculations of bore-hole values on the data obtained from the cores and sludges embodies the opinions of the writer only. So many factors enter into the computation of the final values that most mines content themselves with reporting the main essentials of the bore-hole results only, such as horizons, assay values of each pull, percentage recovery, and true width of the ore-body. The factors involved in the calculation of the final values may be divided into two classes ; those which can be treated mathematically and those which from the nature of the operations can only be assumed from an inspection and study of the characteristics of the cores and sludges.

In the case of cores, the essential data and calculations are simple, the following giving an idea of the general requirements and practice.

(1) Sample and Serial Numbers.

(2) Horizon and Theoretical Length of Sample.

(3) Actual Length, Diameter, Weight Density and Angle of Intersection of Sample.

(4) True Width.

(5) Percentage recovery by length.

(6) Theoretical Weight of Sample.—This is calculated from the formula : Diameter ^{2} (in inches) $\times$ 0·34 $\times$ density $\times$ theoretical length (in feet).

(7) Percentage Recovery by Weight.—From :—

$$\frac{\text{Actual Weight of Sample} \times 100}{\text{Theoretical Weight of Sample}}$$

(8) Assay Values per cent. for Total Copper, Oxide Copper and Iron.—The determination of iron is necessary for the calculation of the sludges in order to allow for the free iron introduced during drilling by shot and the abrasion of bit, core-barrel, rods, and casing.

(9) Feet per cent., Total Copper and Oxide Copper for each pull.—Usually, the percentage of assay value is multiplied by the theoretical length, or, as it is sometimes called, the length represented. In the writer's opinion, however, in order to guard against erroneous results which may be obtained through variations in the angle of dip, the assay values should be multiplied by the true width. This may be a refinement, and not always necessary, but the working out of any simple example will show that it is a step in the right direction.

When the grade of the ore-body is reported by length represented or by true width, the total of the feet-per cents. is divided by the total distance penetrated by the drill through the ore-body or by the true width, as the case may be. The result as obtained by the above method assumes that the core recovered is representative of the ground drilled, whether the full recovery has been made or not. It does not take into account variations of density.

(10) True Width × Density × Recovery % × Cu % (Total and Oxide) for each pull.—The figure arrived at from the above formula compensates for the variations mentioned in the preceding paragraph, and when the figures for each pull are combined, gives the value by weight recovered of a sample having uniform diameter throughout the ore-body.

The calculation of the sludges is not so straightforward as that of the cores, some of the factors being empirical and some based on assumption. The data required and method of calculation are as follows :—

(1) Sample and Serial Numbers.

(2) Horizon and Length of Sludge Sample.

(3) Diameter of Drill-Hole.—To arrive at this, in the case of shot-drills, the difference between the diameter of the core and the inside diameter of the bit is added to the outside diameter of the bit. Recent experiments have shown that in certain cases $\frac{1}{16}$ in. should be added to the measurements thus obtained, but this constant should always be ascertained for different types of ground. For diamond-drill holes, in Roan Antelope ground, it has been found good practice to add 0·02 inch to the greatest width across the outside diamonds of the bit. Although from observation, the diameter of a diamond-drill hole is more constant than that made by a shot-drill, it is probable that any marked decrease in the diameter of the core will mean a certain widening of the diameter of the hole, and this possibility should always be kept in mind.

(4) Theoretical Weight of 100% Core + Sludge.—This is calculated from the following formula :—Diameter of hole^2 (in inches) × 0·34 × density of corresponding core × sample length (in feet). It will be noted that the density of the sludge in situ is assumed to be the same as that of the corresponding core.

(5) Theoretical Weight of Sludge Sample.—This is arrived at by deducting the actual weight of the corresponding core from the theoretical weight of 100% core × sludge, as given above.

(6) Actual Weight of Sludge Sample.—This is subject to a correction, as the sludge almost invariably contains free iron introduced during drilling. To arrive at the correct weight, the actual weight is multiplied by a correction factor derived from the following formula :—

$$\text{Correction Factor} : \frac{100 - \text{Sludge Iron}\%}{100 - \text{Core Iron}\%}.$$

The percentage of natural iron in the sludges is assumed to be the same as that in the corresponding cores.

(7) Percentage Recovery by Weight.

(8) Assay Values per cent. for Total Copper, Oxide Copper and Iron.—The total and oxide copper values for each sample are also subject to a correction for the same reason which made it necessary to correct the actual weight. The correction factor is the same, but it is used as a divisor instead of a multiplier as previously.

(9) True Width × Density × Recovery % × Cu % (Total and Oxide) for each pull.—When the data for cores and sludges, corrected where necessary, are available, the essential figures, such as horizons, weights, percentage recoveries and assay values for the corresponding pulls, are entered on a separate sheet, and the combined percentage recoveries calculated, the results thus obtained being laid out in a convenient form for inspection. The problem which then comes up for consideration is so to combine the results as to arrive at a figure indicative of the true value of the ore-body.

Various methods of calculating this are used at different mines, and all of the results derived therefrom are, or should be, subject to modification depending on the local conditions encountered in each bore-hole, but, whichever formula is used, it must be fundamentally and mathematically correct, as the engineer must have a sound basis on which to compute his final values. Some of the various formulæ used are not applicable to all conditions and do not allow for all the factors involved. The theoretically perfect formula is that which reduces the actual sample taken through the ore-body to the form of a theoretically perfect sample, in other words, a formula which gives the same result as would a sample taken from a drill-hole of uniform diameter throughout. The writer and those associated with him have devoted considerable time to the question and have come to the conclusion that the only formula which satisfies the above requirements is as follows :—

When TW = True Width ; D = Density ; OR% = Overall or Combined Recovery % of Core and Sludge ; CW = Actual Weight of Core ; SW = Actual Weight of Sludge ; CV% = Assay Value of Core ; SV% = Assay Value of Sludge, for each pull, then,

Combined Assay Value =

$$\frac{\text{Summation}\left\{\text{TW}\times\text{D}\times\text{OR}\%\times\left\{\frac{(\text{CW}\times\text{CV}\%)+(\text{SW}\times\text{SV}\%)}{(\text{CW}+\text{SW})}\right\}\right\}}{\text{Summation (TW} \times \text{D} \times \text{OR}\%).}$$

The above formula compensates for varying diameters, angles of intersection and densities and an inspection will show that the result is really the combined assay value by weight of a sample projected normal to the ore-body taken from a drill-hole of uniform diameter throughout.

It must be emphasized that the percentage recovery and assay value factors in the above formula are liable to modification depending on the conditions in each pull. For example, as it is much better to take a positive sample such as core in preference to sludges which may be unreliable, in cases where approximately 100% core is recovered, the sludges may be ignored and the actual percentage recovery and assay value of the core used.

It is a wise procedure to compare the combined assay value of the cores and sludges with that of the cores and sludges calculated separately, using the same formula. An inspection of the data sheets and sampler's reports by the engineer will usually reveal whether faulty technique, or natural causes beyond control, have been responsible for any discrepancies in the core and sludge results. Discrepancies, unfortunately, do occur, and may be due to any of many causes. Some may be remedied, or may have very little bearing on the final results. Others, such as those due to sudden caving, or the impoverization or enrichment of the sludges owing to the mineralization occurring in the more or less resistent portions of the ore-body, are unavoidable, and a conservative allowance may be made for them in the light of local experience and knowledge of the history of the bore-hole as interpreted from its results.

ELECTRICAL EXPLORATION IN CIVIL ENGINEERING

The practical results obtained in several civil engineering problems by the use of resistivity measurements of the underlying ground are described by E. G. Leonardon in Technical Publication No. 407 of the American Institute of Mining and Metallurgical Engineers. The author states that resistivity measurements have been used in mining and oil exploration for a number of years. Their introduction in the field of civil engineering, on the contrary, is rather recent. It was applied for the first time in the spring of 1928 near Littleton, N.H., in the survey of two dam sites for the New England Power Assn. Since then, the geophysical firm with which the author is connected has had an opportunity to develop this field of activity, and more than 20 investigations at dam and tunnel sites have been carried out in the United States and Canada. A part of this work has been verified by underground or drilling exploration.

The paper deals with a few results, which are permitted to be made public. The theoretical and technical sides of the processes employed are not discussed; they have already been described in various technical publications.

Resistivities of the Rocks.—The surveys are based on the measurement of the specific resistance of the rocks. This resistivity is the electrical resistance of a cylinder of rock, having as height the unit of length and as section the unit of surface. The ohm per meter-meter square has been adopted as a practical unit, because this unit of measurement gives convenient figures, usually varying from one ohm to a few thousand ohms.

The electrical conductivity of the sterile rocks (that is, of all rocks, with the exception of a few metallic sulphides which possess a metallic conductivity) is purely electrolytic and disappears when they are entirely dry. From this, it results that the resistivity of a rock is inversely proportional to the amount of water it contains, and roughly inversely proportional to the quantity of ionized salts dissolved in this water. If a rock is very compact it is evident that the amount of moisture it contains is exceedingly small, and that its specific resistance, therefore, is considerable. This is true of rocks like granite, gneiss, marble and, in general, of all metamorphosed or compact rocks, where only a limited number of open spaces or pores exist. On the other hand, rocks with a high water content, like clays, marls, soft limestones, shattered zones, and wet faults, show a good electrolytic conductivity. These differences in the conductivities of the rocks are well characterized by some figures.

Clays and unconsolidated clayey formations often possess resistivities as low as 10 or 30 ohms, clayey-calcarous soft terrains show corresponding figures between 20 and 400 ohms; eruptive or metamorphic masses may have resistivities ranging from 200 to 2,000 ohms and up, according to their lack of porosity. As to the sands, their resistivities will vary greatly according to their dryness and to the impurities contained therein (clay or organic matter). Pure siliceous sands may have great resistance, because the absorbed water contains a very small percentage of dissolved salts. These data show the interest of resistivity measurements to civil engineering. They will not only permit a picture of the general underground conditions (thickness of an overburden, study of a contact between two rocks, location of a fault, etc.) but they will even make it possible to predict, with more or less certainty, the mechanical properties of the underlying formations. As pointed out above, there is often a definite relation between the compactness, the mechanical resistance of a rock and its electrical conductivity. It is true that the occurrence of pure sands, which are electrically very resistive and mechanically loose, will complicate the investigations, but even in this case the electrical study may present an interest, since it will permit the differentiation of an impervious material like clays, boulder clays, from a pervious one, such as sand.

In determining the resistivities of the rocks, two different procedures can be employed. In the first, an invariable measuring arrangement is utilized. A layer of the soil of uniform thickness is investigated over a given area. This is called a "horizontal exploration." In the second, a series of electrical measurements is carried out at a single station to determine the electrical properties at various depths. This operation determines the variation of the electrical parameter with reference to the depth of investigation and is called an "electrical vertical drilling." These two processes have different objects and are discussed successively.

Field Material.—Whichever method of exploration is employed, the material and apparatus necessary to carry out the field measurements are exceedingly light, practical, and not at all cumbersome; they comprise a potentiometer, some electrical batteries, and a few reels of insulated cable. Each piece can be handled conveniently by a single individual, even under the most trying conditions. This makes it especially valuable when the place of work is difficult of access, as is often the case in a preliminary survey upon the results of which depends the further development of the project.

Horizontal Exploration. — In horizontal exploration, the measuring arrangement (in other words, the length of the line AB into which the current is sent) possesses an invariable dimension. The depth of investigation, therefore, is uniform, and a certain thickness of the soil, always the same, is methodically explored by the electrical measurements. These measurements can be summarized or represented, according to circumstances, in the form of profiles or maps of resistivity. These are comparable to the geological cross-sections and maps prepared by the geologist, except that they are not concerned with purely superficial observations, but with the measurement of a parameter which takes into consideration a certain thickness of the ground. Also, another difference is that the underlying terrains are no longer differentiated by their lithological characters, but by their electrical parameters.

The similarity to the geological map often will be striking in shallow-depth investigation. As a matter of fact it would be an error to imagine that only the observations at great depths are valuable in the investigation of underground conditions. Often the sound rocks although practically outcropping, cannot be observed by the geologist because of a thin layer of soil, and a superficial and rapid electrical survey would quickly give evidence of them.

The author then gives results of an exploration at Bridge River Tunnel in British Columbia, in which the correspondence between the electrical

resistivities and the mechanical properties of the rocks was remarkable.

Electrical Vertical Drilling.—In "electrical vertical drilling," the technique of the measurements is entirely different. It consists in carrying out at the same station a series of readings with different lengths of lines *AB*. Thus, the electrical resistivity is studied at different depths along the vertical line passing through the point of station. With this information at hand, the geophysicist will endeavour to predict the underground conditions occurring under the point of station. It must be stressed immediately that the problem thus outlined does not always lend itself to a satisfactory solution. In general, numerous heterogeneities occur at the same time and effect the surface measurements. These heterogeneities are located either near the surface or at depth and are entirely unknown. They may be very irregular and very complicated. Since the geophysicist has no way of differentiating them and studying them separately, a prediction of the underground conditions is often impossible.

Fortunately, there are some simple cases where the electrical vertical drilling can be readily interpreted, among them being one in which there are several homogeneous isotropic, horizontal, parallel layers possessing distinct electrical conductivities. This case can be treated mathematically and is often encountered in geology in its more or less ideal form. In this instance, there are no perturbations in the surface measurements except those caused by the different layers. In applied geology the solution of this problem is of considerable moment, since it makes possible the underground investigation of horizontal formations.

This electrical study of horizontal layers also finds its application in civil engineering. Very often, for instance, the rocks outcropping at a proposed dam site are made up of unconsolidated formations, upon which it is not safe to erect a dam, and it becomes necessary to ascertain at what depth a solid foundation exists. A similar problem is encountered in tunnelling work. If the bedrock does not outcrop all the way along the proposed tunnel line, an exploration is required in order to determine whether there is a safe cover of solid rock above the projected work. If both the surface and the bedrock topography are not exceedingly rough and remain somewhat parallel, the electrical exploration furnishes an expeditious way of computing the thickness of the overburden at numerous places, and of establishing quickly a topographic map of the bedrock. If the overburden is made up of several layers electrically differentiated, often it will even be possible to give an idea of their respective thicknesses.

It is evident that, if the problem is to be solved, the different formations to be distinguished must not possess the same electrical conductivity. It is also necessary that the theoretical conditions of the investigation of homogeneous, horizontal, parallel layers be approximately realized. If the surface and the bedrock topography are decidedly irregular, or to a too great extent not parallel, if the layers are very lenticular, or lack uniform electrical conductivities, etc., the interpretation may become difficult or unreliable. These facts must be borne in mind when discussing the accuracy of the process. It is impossible to give definite figures that will be correct for all practical cases. The accuracy is entirely dependent upon the degree in which the ideal conditions pertaining to the problem of horizontal layers are realized.

In practice, an approximate idea of the correctness of the results is easily obtained after a few depth determinations on the field. The resistivity curves corresponding to the measurements are computed and compared to the theoretical diagrams. From their form, and from the order of magnitude of the discrepancies observed in the two kinds of curves, it becomes possible to see to what extent the problem is amenable to electrical prospecting. The experience proves that the compact rocks, which constitute the bedrock, are generally homogeneous over large areas. This can also be said, although to a lesser degree, of the soft formations which constitute the overburden. It is, then, rather unusual that a dam site problem will not lend itself to the electrical process for solution. In the study of more than 20 dam sites, but one case has been encountered in which the electrical measurements were entirely uninterpretable.

Details are then given of an exploration on the St. Lawrence River, near Morrisburg, Ontario, and of a survey on the Lièvre River, near Masson, Quebec.

Conclusions.—The practical examples of exploration discussed in the paper show how the resistivity measurements of the underground can efficaciously supplement the geological information in the study of certain engineering projects. According to the problem at hand, the geophysicist has two procedures of exploration at his disposal; namely, the horizontal exploration and the vertical electrical drilling, or vertical exploration. The studies presented are, strictly speaking, structural studies which are encountered almost in an identical form in mining or oil exploration. It is evident that the mapping of a contact, the tracing of a fault, the following of a series of tilted beds, hidden under an overburden, often will be conveniently solved by a horizontal exploration and the preparation of a resistivity map. The same process will also enable the location of a buried plug (conductive or resistive) encased in formations of different conductivities, a problem which crops up in the exploration for salt domes. On the other hand, problems like that of outlining buried river channels carrying high values in gold and silver, or locating mineralized pockets near the surface, are not different from the study of the thickness of an overburden at a dam site and will be treated by the same technique.

The advantages of the electrical method are its rapidity and economy, which makes it particularly valuable in preliminary surveys where a general outline of the underground conditions is required immediately. From the results obtained, it is generally possible to orient an underground or drilling exploration with a minimum of cost. It is also well to mention that in numerous cases a mere electrical survey will put in evidence the unfavourable conditions that may exist at a proposed dam site, or tunnel location, etc., thereby saving any further unnecessary expenditure. That the process is rapid and economical is demonstrated by the following figures. The survey at Bridge River required only four working days. The work at Morrisburg and Masson were performed in 30 and 33⅓ working days respectively. During the course of these last two explorations, 176 depth determinations were made, which cost the companies about $10,000. These data show that an average of 2·8 depth determinations were made by the prospecting party per working day, although one of the surveys was performed during the Canadian bad season under adverse weather

conditions. They further show that the cost of a depth determination averages less than $60, which is a low figure, considering the information furnished. For surveys of very short duration, the cost per vertical drilling is a little higher, although not to any considerable extent.

Another point to be stressed is the fact that the field equipment is very light and can be transported easily. It weighs only a few hundred pounds and the parts are sufficiently small to be conveniently carried about. An observer with the aid of three or four workmen can operate almost anywhere, whatever may be the topographical conditions and the vegetation. This advantage presents a special interest in a preliminary investigation, upon the results of which will depend entirely the further development of the engineering project. The most complete and satisfactory results will be realized when a close co-operation is maintained between the geologist and the geophysicist. The former with his knowledge of the site to be studied, and of its surface geology, will orient the electrical observer, thus avoiding any unnecessary work in the areas already known. He will also, with his knowledge of the rocks of the region, their lithologic characteristics and mechanical properties, be able to help greatly in the interpretation of the results.

LEACHING OF COVELLITE

In the issue of the MAGAZINE for September last a digest was given of Technical Paper 473 of the United States Bureau of Mines in which J. D. Sullivan dealt with the chemistry of leaching chalcocite. A further paper by the same author has now been issued and this, Technical Paper 487, deals with the chemistry of leaching covellite.

The author states that although not so abundant as chalcocite, bornite, and chalcopyrite, covellite is quite widely distributed in nature and is frequently found associated with chalcocite or bornite. Chalcocite may also hold covellite in solid solution. Many of the ores of the west and south-west United States contain considerable covellite. The United States Bureau of Mines in its investigations of the chemistry of leaching all important copper minerals likely to be found in leachable ores has made a study of the chemistry of leaching covellite, and in most of the studies ferric sulphate has been employed as the leaching reagent. Pure covellite, CuS, contains 66·47% copper and 33·53% sulphur.

Three samples of covellite were used in this investigation—two from Kennecott, Alaska, and one from Butte, Mont. The latter was crystalline and the two former were massive. The chemical analyses of the minerals are given in the accompanying table. Polished sections were made of the crushed minerals embedded in bakelite. The microscopic examination showed that the Butte covellite was virtually pure. The total sulphide impurities probably did not exceed 5%. The principal impurity was chalcocite, although a small amount of bornite was also present. The Kennecott No. 1 covellite was not so free from impurities as the Butte product; the total sulphide impurities amounted to about 10% and consisted largely of chalcocite, although some chalcopyrite was also present. The Kennecott No. 2 covellite contained probably 15% sulphide impurities. Chalcocite was the principal impurity; bornite and chalcopyrite were absent.

CHEMICAL COMPOSITION OF COVELLITE SAMPLES

Mineral	*Total copper* %	*Iron* %	*Sulphur* %	*Insoluble* %	SiO_2 %
Kennecott No. 1 :					
− 100 + 200 mesh	66·39	0·45	31·94	0·34	....
Kennecott No. 2 :					
− 3 + 10 mesh	67·92	·47	31·03	·38	0·20
− 10 + 28 mesh	68·12	·47	30·95	·30	·16
− 100 + 200 mesh	68·14	·45	31·04	·32	·14
− 200-mesh	67·60	·53	30·81	·78	·44
Butte :					
− 3 + 10 mesh	66·84	·84	31·92	·30	·20
− 10 + 28 mesh	63·18	1·06	30·59	4·98	4·22
− 100 + 200 mesh	64·46	·98	31·72	2·76	2·38
− 200-mesh	64·62	1·37	31·69	1·64	1·42

The experimental work in the report considers (1) the effect of size of particles of mineral upon the rate of solution; (2) the effect of the concentration of ferric iron in the leaching solution; (3) the effect of the concentration of sulphuric acid in the leaching solution, the ferric iron content remaining constant; (4) the effect of temperature; (5) the rate of solution of covellite in ferric chloride solutions; (6) the rate of solution of covellite in sulphuric acid; and (7) the mechanism of solution of covellite in ferric sulphate solutions. Nearly all tests were performed in a room having thermostatically controlled temperatures.

The usual procedure was to weigh out a 10-gram sample of mineral and put it into a 5-pint bottle. The bottle containing the sample of covellite was then placed in the constant-temperature room to bring it to the proper temperature. After 500 c.c. of the desired leaching solution, which also was at the proper temperature, was added the bottle was put on a set of revolving rolls to agitate the solution and mineral. The mouths of the bottles were left open (that is, not stoppered) unless otherwise stated. Samples were removed for analysis from time to time. The procedure of sampling was as follows: The bottle was shaken to remove any solid material from the inside walls; after the solids had settled 400 cc. of solution was siphoned off, using a filter pump. Then 400 cc. of fresh leaching solution was added. The concentration of leaching reagents was thus kept fairly constant. Samples were pipetted from the 400 cc. of removed solution and analysed. Solution was added when necessary to offset evaporation losses.

Neutral ferric sulphate as used in this work meant chemically pure ferric sulphate without the addition of any acid from outside sources. The solution actually had an acidic reaction and usually contained some free acid.

When covellite is dissolved by ferric sulphate the reaction may be written:

$$CuS + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4 + S.$$

The stoichiometric relations require that 1·757 grams of ferric iron be reduced to the ferrous condition for every gram of copper converted into the sulphate. Impurities in the mineral may cause a difference in the ratio; moreover, owing to the agitation of the solution with air during the treatment on the revolving rolls, some of the ferrous iron may be reoxidized to the ferric condition. When sulphuric acid is also present the mineral is attacked partly by the acid.

As a result of this work, the following conclusions were made. Covellite can be leached with ferric sulphate and the sulphide converted into the

soluble sulphate. Simultaneously with the solution of copper, ferric iron is reduced to ferrous iron.

The experiments described in the report showed that the rate of solution of — 100 + 200 mesh covellite was virtually the same in solutions containing 1 and 2% of trivalent iron. The rate of solution of — 10 + 28 mesh covellite was not markedly different in solutions containing 0·5 to 2% of trivalent iron. As ferric salts reduce current efficiency and necessitate higher current densities in electrolytic precipitation, it is desirable to keep the concentration as low as possible. A low ferric iron content is also desirable in plants making cement copper.

The rate of solution of covellite was practically independent of the strength of acid for the first eight days when the ferric iron concentration remained constant at 1%. After eight days the rate of solution was slightly slower in the solution containing 0·25% sulphuric acid than in solutions stronger in acidity.

The finer the particles were crushed the faster covellite dissolved. When large pieces of covellite were leached in ferric sulphate they did not disintegrate, but retained nearly their original outline. Apparently the sulphur left behind retained the original form of the mineral particle.

Sulphuric acid in the presence of excess atmospheric oxygen attacked covellite, but did so at about one-half the rate that the material was attacked by ferric sulphate.

The rate of solution was markedly affected by temperature. When — 100 + 200 mesh Kennecott was leached with ferric sulphate 81% of the copper was dissolved in 14 hours at 98° C., whereas the extraction was 41% in 24 days at 35° C. and 81% in 22 days at 50° C. The slow rate of solution of covellite in ferric sulphate at ordinary temperatures and the marked acceleration of the rate of extraction with increase in temperature indicate the desirability of agitation leaching with hot or boiling solutions, especially if the ore is rich in covellite. The rate of solution was more rapid in ferric sulphate than in ferric chloride solutions at 35° C., but the rates were virtually the same at 98° C.

The artificial covellite produced when chalcocite was leached with ferric sulphate dissolved at a much faster rate than did natural covellite.

The covellite from Kennecott dissolved at a more rapid rate than that from Butte. Chemical and microscopic examinations indicated that the former contained more chalcocite than the latter.

Although these experiments were made with relatively pure minerals, the data are applicable to any leaching ore containing covellite. The rate of solution of covellite in different ores may vary because of such factors as differences in mineralogical associations, in the rate at which solutions penetrate into the particles of ore, and in reagent-consuming constituents present, etc.

CHROMITE IN ONTARIO

The occurrence of chromite deposits at Obonga Lake, 80 miles north-west of Port Arthur, Ontario, is described by M. E. Hurst in the *Canadian Mining Journal* for January 16. The writer says that the occurrence of chromite in the Obonga Lake area and the initial exploration of the deposits have been described by A. R. Graham in a preliminary report issued in 1929. Since then the Consolidated Chromium Corporation (a subsidiary of the Golden Centre Mining Company), the only organization operating in the district, has opened up additional chromite-bearing zones on its property and has begun underground development on one of its most promising showings.

The chromite deposits are associated with a lenticular body of serpentinized peridotite having a maximum width of approximately ¾ mile and a length east and west of about 3½ miles. This body is bordered on the north by granite and quartzite and on the south by metamorphosed sediments, chiefly quartzite and conglomerate. The peridotite intrusion is definitely younger than the adjoining sediments. Its relationship to the granite is more obscure, but it is believed to be older. All the area known or thought to be underlain by peridotite and serpentine has been staked. While the principal discoveries are located on the 52 claims controlled by the Consolidated Chromium Corporation, disseminated chromite has also been found in an outcrop of peridotite on the MacDonald claims which adjoin the corporation's ground on the north-west. Five chromite-bearing zones, referred to as A, B, C, D and E, have been discovered to date on the corporation's property.

The " A " zone is located on or near a group of islets at the north end of Chrome Lake. Surface trenching and diamond-drilling have so far indicated an area of about 150 ft. in diameter in which the serpentinized peridotite contains grains of chromite disseminated through it. According to the management one section, 150 ft. long, across the zone contains an average of 12% Cr_2O_3.

The " B " zone lies about 600 ft. east of Chrome Lake and between the " A " and " E " zones. It consists of a flat lying body of chromite, about 2 ft. thick, exposed over an area 150 ft. in diameter. This is estimated by the management to contain about 5,000 tons of material running 34% Cr_2O_3. The underlying peridotite contains some disseminated chromite.

In the " C " zone there are several small patches of chrome-bearing peridotite which have been exposed by trenching within 200 ft. of the east shore of Chrome Lake. The peridotite in this section also contains considerable magnetite.

The " D " zone lies on the west side of Chrome Lake about 500 ft. west of the " A " zone. It consists of some half-dozen exposures of peridotite containing chromite present as disseminated grains or occasionally concentrated into streaks. The better grade material probably contains 15 to 20% Cr_2O_3. Further exploration will be necessary in order to determine whether these showings are related to one another and whether they mark the westward continuation of the " A " zone.

The " E " zone is located near the east end of the peridotite body and about 3,000 ft. south-east of the " A " zone. It consists of several branching, veinlike bodies (schlieren) of chromite lying about 30 ft. apart and roughly parallel to one another. The veins strike N. 60–70 E. and appear to merge toward the north-east. They range in width from 1 to 7 ft. and dip at a low angle to the south. Sampling of the surface showings gave, according to the management, an average of 36% Cr_2O_3. The most persistent vein has been traced by trenching

for about 500 ft. A shaft, located at the widest point on the most southerly vein, has been sunk to a depth of 350 ft. Owing to their southward dip, the chromite bodies exposed near the collar of the shaft were penetrated within a depth of 60 ft. At the 100 ft. level cross-cuts were run north for 200 ft. and south for 320 ft. These intersected a 200 ft. width of serpentinized peridotite and associated talc-chlorite schists lying between walls of micaceous quartzite. Except for several narrow, comparatively high-grade concentrations of chromite, most of this width consists of low-grade material containing sporadically disseminated chromite. At the time the property was visited about 25 ft. of cross-cutting had been done at the 225 ft. level and none at the 350 ft. level.

The exploratory work which has been done on the deposits in this area shows that the chromite occurs either as comparatively high-grade, veinlike streaks, patches and segregations, or as grains finely disseminated through certain portions of the peridotite. There is little evidence available as yet to indicate that the chromite occurrences are due to gravitative segregation toward the foot-wall of the peridotite body, in fact, they appear to be unrelated to any structural features within the peridotite mass, and hence their occurrence, as regards size, shape, continuity, location and distribution, is difficult to predict and can only be determined by extensive prospecting and exploration. It is believed that the higher grade chromite concentrations owe their origin to processes of segregation which went on in widely separated parts of the peridotite body and which were most active during the early stages of its cooling and crystallization. Subsequent shearing by squeezing out the less resistant silicate minerals has, in some instances, served to increase the original chromite concentration. There appears to be no reason why deposits, similar to those already found, should not occur elsewhere within the peridotite body.

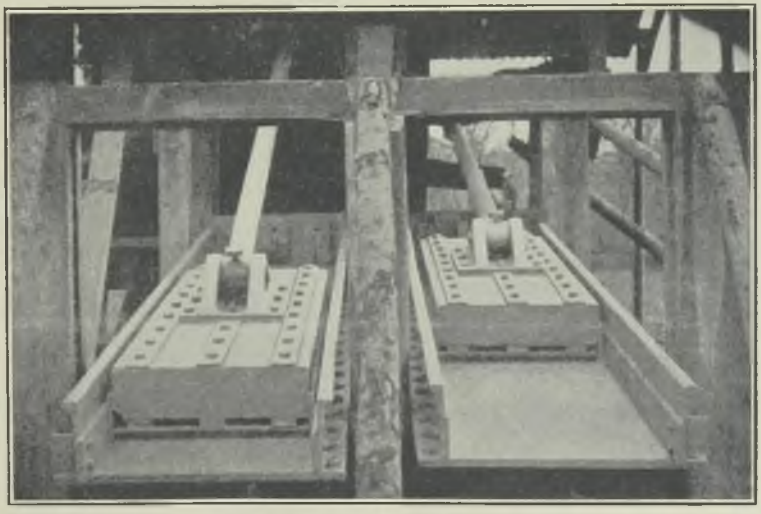
Differential Abrasive Milling.—At the fifth general meeting of the Cornish Institute of Engineers on February 14, Mr. J. G. Cloke read a paper entitled "Differential Abrasive Milling and Accessories, with reference to their bearing on the Tin Industry as seen in Cornwall."

In his paper the author points out that the first requirement of milling is the liberation of ores from gangue in an even state of sizings. In no case is the hardness factor a more valuable asset than in that of tin oxide, but in ordinary milling the advantages are lost by subjecting the ore to percussive liberation. A preliminary breaking of rocks must be performed by means of a Gates breaker, or other suitable means, to a given size. This size can only be determined by a careful investigation of the character of each individual ore. For the purposes of the paper this is assumed to be ½ in. Having completed this initial stage, all further reductions in size can be more perfectly and economically performed by abrasion, instead of percussion. Although working under arduous conditions the author claims that he has liberated the majority of the tin grains intact and without their having undergone unnecessary reduction in size.

The accompanying photograph illustrates in end view a pair of mullers in position at an adjustable incline. A fall of 1½ in. per ft. appears to be the incline generally suitable for wet crushing. The channel consists of 2 plates, one of which is a removable bed or lining. The sides of the inclined channel are fitted with adjustable rubbing-plates. The mullers are standing respectively at the top and the bottom of their stroke. Being 2 ft. wide with a stroke of 4 ft. the clearance area is 1,152 sq. in. The weight of the pair of mullers is 1,200 lb., and the shoe area when new about 1,000 sq. in. The mullers are attached by means of a connecting-rod to a crank-shaft 2 ft. from centre to centre, giving a 4 ft. stroke, and belt-driven at 25 to 36 r.p.m. It is reckoned that not more than 8 h.p. was obtainable from the engine used for tests and subsequent working.

Requirements are that the bed be truly laid ; the sides equally truly laid, and sealed ; and that the muller be given perfect freedom in regard to its vertical place and be of the lightest weight compatible with robust structure.

The material treated was quartz capel carrying



MULLERS IN POSITION.

pyritic ore, crushed to ¾ in. and calcined for recovery of arsenic. An output of 12 tons per h.p. day has been achieved, but it is preferred to claim that the machine will reduce ordinary ores from about ½ in. to any degree of fineness at the rate of 7·5 tons per h.p. day. The author claims that the results of work accomplished indicate that, including a higher recovery than is now obtained (a loss of 8 lb. per ton being generally admitted), and a substantial cheapening in costs, the substitution of abrasive for percussive milling will secure an advantage of 4s. to 6s. per ton treated.

Action of Sulphur Dioxide on Manganese Oxides.—Three progress reports on a study of the hydro-metallurgy of manganese, bearing on different phases of the problem, have been prepared by the Bureau's Rare and Precious Metals Experiment Station, Reno, Nevada, in cooperation with the University of Nevada. The view is held that Sulphur Dioxide may be the means of future utilization of the large deposits of low-grade manganese ores in the United States. One of the progress reports involves the solution of manganese from ores. Sulphur dioxide gas, a waste product at many smelters, passing counter current to pulp flow in a specially designed leaching drum, readily dissolves the manganese from the principal oxides and also from the carbonates after calcination. Another report records a study of the oxidation of hydrated oxides of manganese, the object being the production of maximum percentage of the dioxide of manganese. A third report deals with sulphur dioxide and manganese oxides at elevated temperatures. There is now in course of preparation an article on the recovery of manganese from its solution for metallurgical uses.

The third-named paper, designated as Report of Investigations 3033, "The Action of Sulphur Dioxide on Manganese Oxides at Elevated Temperatures," by C. W. Davis, may be obtained from the United States Bureau of Mines.

SHORT NOTICES

Ore Transport.—The transport of ore at the Alaska Juneau mines is described by J. A. Williams in *Mining and Metallurgy* for February.

Clay Mining.—In the *Bulletin* of the Institution of Mining and Metallurgy for February, Cyril Brackenbury describes the mining of potter's clay in South Devonshire.

Ventilation in Arizona.—Bulletin 330 of the United States Bureau of Mines, by G. E. McElroy, contains a study of ventilation methods and costs in the large copper mines of Arizona.

Ventilation in Ecuador.—The method of ventilation at the Portovelo mines, Ecuador, is described by J. P. Harmon in Technical Publication No. 411 of the American Institute of Mining and Metallurgical Engineers.

Toxic Gases from Explosives.—G. St. J. Perrott, L. W. Babcock, C. D. Bilting, and G. W. Jones give the results of an investigation into the amount of toxic gases liberated by the firing of 60% gelatine explosives in Technical Paper 482 of the United States Bureau of Mines.

Flotation Plant in Algeria.—The flotation plant at the lead-zinc-silver mines of the Société de l'Oued-Oudina in Algeria are described by M. J. Priadkine in *Revue de l'Industrie Minérale* for February 15.

Tube-Milling Gold Ores.—Dr. H. A. White gives the results of an investigation into the absorption of gold in tube-mills in the *Journal* of the Chemical, Metallurgical and Mining Society of South Africa for December last.

Ball-Mill Studies.—The results of an experimental study of some of the factors entering into ball-mill grinding are given by A. W. Fahrenwald and H. E. Lee in Technical Publication No. 375 of the American Institute of Mining and Metallurgical Engineers.

Crushing and Milling.—Crushing practice in the South-West United States and milling in the Coeur d'Alene district are described by D. Cole and W. L. Zeigler respectively in *Mining and Metallurgy* for February.

Dredging.—A paper read before the Institution of Mechanical Engineers by R. J. N. Willcox describes the dredging plant used for deepening the River Thames and records some of the practical experience gained from its maintenance.

Silver in Chemical Plant.—At a meeting of the Chemical Engineering Group of the Society of Chemical Industry held on February 13, D. McDonald read a paper dealing with the application of silver in chemical plant.

Check-Sampling of Bore-holes.—The *Bulletin* of the Institution of Mining and Metallurgy for February contains an account by G. F. Hatch of the measures used to check-sample diamond drill-holes at the Trepca lead-zinc-silver mines in Yugoslavia.

Measurements of Resistivity.—L. Gilchrist describes measurements of resistivity by the central electrode methods at the Abana mine, Quebec, in Technical Publication No. 386 of the American Institute of Mining and Metallurgical Engineers.

Magnetic Surveying.—A magnetic method of estimating the height of some buried magnetic bodies is described by A. S. Eve in Technical Publication No. 408 of the American Institute of Mining and Metallurgical Engineers.

Magnetic Susceptibility.—W. M. Barret, in Technical Publication No. 394 of the American Institute of Mining and Metallurgical Engineers, outlines a method for determining the magnetic susceptibility of core samples.

Newfoundland Iron Ore.—A. O. Hayes describes the structural geology of the Concepcion Bay region and Wabana iron ore deposits in *Economic Geology* for January–February.

Origin of Witwatersrand System.—A paper read by L. Reinecke before the Geological Society of South Africa on December 8 last discussed the origin of the Witwatersrand system.

Gold-Bearing Pyrite in the Pyrenees.—A note on an occurrence of gold-bearing pyrite in the Province of Huesca in the Spanish Pyrenees is given by N. Dégontin in *Mines, Carrières, Grandes Enterprises* for February.

South African Diamond Mines.—The *Journal* of the Franklin Institute of Philadelphia for February contains an article by F. Lynwood Garrison on the diamond mines of South Africa.

Re-Forming Natural Gas.—Means and processes for the re-forming of hydrocarbon gases, including refinery gases, are covered in Technical Paper 483 of the United States Bureau of Mines by W. W. Odell.

Petroleum Refining.—Bulletin 333 of the United States Bureau of Mines, by H. P. Rue and R. H. Espach, deals with the refining of light petroleum distillates.

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.*

28,434 of 1929 (340,242). L. ANDREWS, London. Classification by elutriation methods, by which the material to be separated flows longitudinally at low velocity through a classifier having one or more settling hoppers in the lower portion.

29,555 of 1929 (340,586). FLODINJERN AKTIEBOLAG, Stockholm. Crushed ore is mixed with binding and reducing agents, briquetted, and heated in casings or shells, in order to produce metal sponge.

29,582 of 1929 (340,497). ELECTRICAL RESEARCH PRODUCTS, INC., New York. Metallic copper, which may be subsequently heated without becoming embrittled and which at the same time possesses high electrical conductivity, is prepared by keeping molten pure copper in a vessel with refractory lining and adding a deoxidizing agent.

29,595 of 1929 (340,562). FLODINJERN AKTIEBOLAG, Stockholm. The casings or shells in patent No. 340,586 above, are made of refractory material with inwardly directed projections which ensure uniform heat conditions in the shell.

29,905 of 1929 (340,598). H. LAVERS and MINERALS SEPARATION, LTD., London. Means for the control of flotation " poisons " in a mineral pulp by the addition of an oxidizing agent, which may be added during grinding.

39,525 of 1929 (341,246). S. O. COWPER-COLES, Sunbury-on-Thames. The production of metallic tubes and shaped articles by electro-deposition on copper or brass-coated mandrels which are highly polished and coated with beeswax dissolved in turpentine, to which 1% of CS_2 is added to 0·5% beeswax in turpentine.

8,161 of 1930 (340,451). SOCIETY OF CHEMICAL INDUSTRY IN BASLE, Switzerland. Light metals are obtained from the electrolysis of molten haloids, the metal rising to the surface of the molten electrolyte.

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.

Elementary Economic Geology. By PROF. H. RIES. Cloth, octavo, 360 pages, illustrated. Price 18s. 6d. London : Chapman and Hall. New York : John Wiley and Sons.

Elements of Engineering Geology. 2nd edition. By PROF. H. RIES and Dr. T. L. WATSON. Cloth, octavo, 411 pages, illustrated. Price 18s. 6d. London : Chapman and Hall. New York : John Wiley and Sons.

Minerals in Modern Industry. By Dr. W. H. VOSKUIL. Cloth, octavo, 350 pages. Price 18s. 6d. London : Chapman and Hall. New York : John Wiley and Sons.

World Minerals and World Politics. By C. K. LEITH. Cloth, octavo, 213 pages. Price 10s. London : McGraw-Hill.

General Stratigraphy. By PROF. J. W. GREGORY and B. H. BARRETT. Cloth, octavo, 285 pages, illustrated. Price 10s. London : Methuen and Co.

The Japanese Earthquake of 1923. By DR. C. DAVISON. Cloth, octavo, 127 pages, illustrated. Price 7s. 6d. London : Thomas Murby and Co.

Miners' Welfare Fund. 9th Report of the Committee and 4th Report of National Scholarship Scheme Committee, 1930. Paper folio, 68 pages, illustrated. Price 1s. 6d. London : H.M. Stationery Office.

Zinc and Lead Deposits of Canada. By F. J. ALCOCK. Geological Survey of Canada Economic Geology Series, No. 8. Paper boards, octavo, 406 pages, illustrated, with map. Price 75 cents. Ottawa : Department of Mines.

Geological Survey of Canada. Summary Report, 1929. Part A, paper covers, 319 pages, illustrated, with map. Part C, paper covers, 50 pages. Ottawa : Department of Mines.

Geology of Southern Alberta and Southwestern Saskatchewan. By M. Y. WILLIAMS and W. S. DYER. Memoir 163 of the Geological Survey of Canada. Paper covers, 160 pages, illustrated. Ottawa : Department of Mines.

Geology of the Country between Gatooma and Battlefields. By A. M. MACGREGOR. Memoir No. 17 of the Geological Survey of Southern Rhodesia. Paper covers, 144 pages, illustrated, with map. Price 4s. 9d. Salisbury : Geological Survey Office.

Tanganyika Territory. A Note on the Geology of the Country around Tendaguru, Lindi District. By DR. JOHN PARKINSON. Paper covers, 16 pages, with plates and maps. Price 2s. London : Crown Agents for the Colonies.

Tanganyika Territory : Land Development Survey, 2nd Report, 1930, Iringa Province. Paper covers, 40 pages, with map. Price 5s. London : Crown Agents for the Colonies.

South Australia. Report of the Director of Mines and Government Geologist, 1929. Paper folio, 8 pages. Adelaide : Department of Mines.

Panama : A Geologic Study of the Madden Dam Project, Alhajuela, Canal Zone. By F. REEVES and C. P. ROSS. United States Geological Survey, Bulletin 821-B. Paper covers, 49 pages, illustrated, with maps. Price 40 cents. Washington : Superintendent of Documents.

Greensand Bibliography to 1930 (Annotated), with a chapter on zeolite water softners. By R. N. SHREVE. Bulletin 328, United States Bureau of Mines. Paper covers, 78 pages. Price 15 cents. Washington : Superintendent of Documents.

Mineral Resources of the United States, 1929. Part I ; pp. 143–177, Silver, Copper, Lead, and Zinc in the Central States, by J. P. DUNLOP and H. M. MEYER. Part II ; pp. 175–194, Sulphur and Pyrites, by R. H. RIDGWAY ; pp. 195–207, Asbestos, by O. BOWLES and B. H. STODDARD. Washington : Superintendent of Documents.

California : Mineral Production for 1929. By H. H. SYMONS. Bulletin No. 103 of Division of Mines, State of California. Paper covers, 231 pages, illustrated. San Francisco : Division of Mines.

Peru : Carbon y Fiero, No. 9. Decretos, Informes, Oficios, Resoluciones, Proyectos de Ley y otros Documentos Oficiales. Paper covers, 154 pages. Lima : Ministerio de Fomento.

Silicosis : Records of International Congress, Johannesburg, 1930. Paper covers, 692 pages. Price 16s. London : P. S. King and Son.

Money versus Man.—By PROF. F. SODDY. Cloth, octavo, 120 pages. Price 3s. 6d. London : Elkin Mathews and Marrot.

COMPANY REPORTS

Geldenhuis Deep.—This company, formed in 1893, works a deep-level property in the Near-East Rand. The report for the year 1930 shows that 908,189 tons of ore was raised from the mine and, after sorting out 96,289 tons as waste, 811,900 tons went to the mill. Here 186,236 oz. gold, worth £790,265, was recovered, as compared with 176,169 oz., worth £747,063, in 1929. Silver and osmiridium brought the revenue up to £792,192, equal to 19s. 6d. per ton milled. The working costs were £731,128, or 18s. per ton, and the working profit £61,065, or 1s. 6d. per ton. Dividends amounting to £49,583, equal to 8¾%, were paid during the year. The available ore reserves at the end of the year were estimated to be 479,700 tons, averaging 5·64 dwt. over a stoping width of 50·1 in., as compared with 504,200 tons, averaging 5·7 dwt., at the end of 1929. Further improvements in the western reduction plant carried out during the year have resulted in an increased capacity and a small improvement in the residues.

Modderfontein B.—This company was formed in 1908 and works a gold mine east of the New Modderfontein in the Far-East Rand. The report for the year 1930 shows that 983,748 tons of ore was mined and, after sorting out 144,348 tons as waste, 839,400 tons was sent to the mill where 293,518 oz. gold was recovered, worth £1,245,227. Silver and osmiridium recovered brought the revenue up to £1,252,341, or 29s. 10d. per ton milled, as compared with £1,294,618, or 31s. per ton, in the previous year. Working costs amounted to £708,905, or 16s. 11d. per ton, and the working profit to £543,437, or 12s. 11d. per ton, as compared with £574,563 and 13s. 9d. per ton in 1929. Dividends amounting to £560,000 were paid during the year, equal to 80%. The available ore reserves at the end of the year were estimated to be 1,112,100 tons, averaging 6·95 dwt. over 51·6 in., as compared with 1,445,400 tons, averaging 7·3 dwt., at the end of 1929. The decrease in the ore-reserves emphasizes the fact that payable development is not keeping pace with the mining. Exploration is to be continued, but it is not expected that any large tonnage of payable ore will be opened up during the current year, so that the present scale of profits is unlikely to be maintained.

Rose Deep.—This company, formed in 1894, works a deep-level property on the East Rand. The report for the year 1930 shows that 787,100 tons of ore was mined and, after sorting 53,650 tons as waste, 733,450 tons was sent to the mill, where 155,841 oz. gold was recovered, worth £660,699. Silver and osmiridium brought the total revenue up to £662,322 as compared with £611,363 in the year before. Working costs amounted to £613,842 and the working profit was £48,480, or 1s. 4d. per ton, as compared with £35,532 and 1s. 1d. per ton in 1929. Dividends absorbing £33,149, equal to 5%, were paid during the year. The available ore reserves at the end of the year were estimated to be 841,900 tons, averaging 4·8 dwt. over 59 in., as compared with 714,300 tons, averaging 4·8 dwt., at the end of the previous year. Satisfactory progress has been made with the opening of the Southern Section, the Hammond incline being equipped to the 18th level and the Lohse north incline to the 17th level. A haulage is being installed on the 18th level to transport ore from the Lohse section to the Hammond incline.

Petaling Tin.—This company was formed in 1920 and works alluvial tin property near Kuala Lumpur, F.M.S. The report for the year ended October 31 last shows that 4,854,630 cu. yd. of ground was treated during the year under review, the recovery being 2,123½ tons of tin concentrates, the figures in the previous year being 6,183,682 cu. yd. and 2,468¾ tons. The profit for the year, after making various allowances, was £75,796, which, with the balance of £19,776 brought in, made an available total of £95,573. Dividends amounting to 30% have been paid which absorb £68,366 and the balance of £27,206 was carried forward. The decreased yardage and output reported were mainly due to the stoppage of No. 1 dredge as part of the accepted policy of output regulation, to the irregularity of the bedrock on the ground worked by No. 3, and to the difficult conditions encountered by No. 4 dredge. Preparations are in hand for the construction of a new dredge on the property.

DIVIDENDS DECLARED

Amalgamated Zinc (De Bavay's).—4%, less tax, payable April 10.

Champion Reef.—1s., less tax, payable April 1.

Kramat Pulai.—6d., less tax, payable March 20.

Malayan Tin.—3d., less tax, payable March 19.

Mysore Gold Mining.—9d., less tax, payable March 28.

Nundydroog.—1s. 9d., less tax, payable April 2.

Oriental Consolidated Mining.—50 cents, payable March 2.

Petaling Tin.—5 cents, less tax, payable February 28.

Robinson Gold Mining.—2s., less tax, payable March 19 (final liquidation).

Tehidy Minerals.—6d., less tax.

Southern Malayan Tin Dredging.—1½d., less tax, payable March 18.

St. John del Rey.—Pref. 1s. tax free; Ord. 1s. 3d. and 6d. bonus, less tax.

Witbank Colliery.—1s., less tax, payable April 1.

NEW COMPANIES REGISTERED

Amari Nigeria Tin Mines (1931).—Registered as a public company. Nominal Capital: £60,000 in 2s. shares. Objects: To acquire the Amari (Nigeria) Tin Mines and to carry on the business of miners of metals, minerals, and precious stones, etc. Directors: T. J. Salt, and Capt. G. Hallett. Office: Balfour House, Finsbury Pavement, E.C. 2.

Power Holdings.—Registered as a public company. Nominal Capital: £10,000 in £1 shares. Object: To finance mercantile, industrial, manufacturing, mining and other businesses; to carry on business as engineers, suppliers of electricity, etc.

Straits and General Development Company (1931).—Registered February 19. Nominal Capital: £30,000 in 2s. shares. Objects: To acquire the undertaking of the Straits and General Development Company, and to carry on the business of miners, planters, etc. Office: Balfour House, Finsbury Pavement, E.C. 2.

Zante Oilfields.—Registered February 21. Nominal Capital: £100 in 2s. shares (500 Preferred and 500 Ordinary). Objects: To acquire the Near East Petroleum Company.