The Mining Magazine

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EDITORIAL

THE forty-sixth annual issue of Skinner's "Mining Year Book" appeared last month. The policy of including particulars of foreign mining companies has been still further expanded in the present issue, the international character of the book increasing its value to all associated with the mining industry.

THE holiday course in economic geology, which has been a feature at the Camborne School of Metalliferous Mining (Cornwall) since 1919, will be held this year from July 11 to August 20. The course is designed to appeal to engineers and geologists home on leave and comprises both laboratory and field work, including geological excursions, visits to mines, and field mapping.

LECTURING last month before the Royal Institution, Sir John Cadman chose as his subject "Petroleum—A Record of Achievement in Applied Science." The lecturer laid great emphasis on the advantages of oil over coal as a fuel, particularly in connexion with railways. In view of recent work on the recovery of oil from coal in this country, his figures regarding the comparative consumptions of oil and coal made a great impression on his hearers.

A COURSE of seven lectures and demonstrations on tropical hygiene, by Major D. T. Richardson, of the Royal Army Medical College, will be given next month at the rooms of the British Red Cross Society, Chesham Street. The lectures will be given on Mondays, Wednesdays, and Fridays, commencing on Monday, April 4, at 5.30 p.m., and will cover such questions as food, clothing, and the medical and sanitary precautions necessary for health in hot countries. The fee for the course is 5s. for members of the society and 7s. 6d. for non-members.

RECENT progress in the elucidation of the geology of Northern Rhodesia was clearly demonstrated at a meeting of the Geological Society of London held last month. After the introduction of a paper on the geology of the N'Changa district, by Dr. G. C. A. Jackson, a brief account of the general geology of the copper belt was given by Mr. G. Vibert Douglas, who made reference to the climatic cycle since Tertiary times and to means of distinguishing between the older and younger granites (the two-granite question being still somewhat controversial), his lecture concluding with a sketch of the general structure of the country. Speakers contributing to the discussion which followed included Dr. Anton Gray, Mr. R. Murray-Hughes, and Dr. L. Hawkes.

The Institution Meeting

The three papers down for presentation at the February meeting of the Institution offered somewhat mixed fare to the large number of members attending. Two of them—"Sand-Filling Methods at Hodbarrow (Hæmatite) Mines, South Cumberland," by Mr. A. Alec Jones, and "The Asbestos Mines at Shabani, in Southern Rhodesia," by Mr. Jack Spalding—doubtless attracted the miners, the third—"Flotation: Some Operating Details," by Mr. Kenelm E. Armytage, drawing those interested in ore-dressing practice. Actually, only two of the papers were introduced and discussed on this occasion, that dealing with Shabani being left—in the absence of the author—for amplification by written contributions to the Transactions. The papers on sand-filling and flotation, however, had evidently created some interest and their presentation and discussion fully occupied the available time.

The first paper to be considered was that by Mr. Jones, full extracts from which will be found elsewhere in this issue. It will suffice here, therefore, if some idea is given of the conditions which led to the adoption of such a method of filling at this Cumberland property, where a large mass of hæmatite ore lying under the sea was mined during the years 1860-1922 by a top-slice caving method. By the latter year it was estimated that about nine-tenths of the Hodbarrow mass had been extracted and it had become increasingly apparent that some other way would have to be found of taking out the remainder, owing to the danger, in the northern section, of inundating the mine by the collapse of water-laden sediments and, in the south, of flooding the mine with sea-water through caving of the sea-bottom. In 1905 the "Outer Barrier"—a large embankment—was completed, an area of

200 acres previously below the high-water mark being thereby reclaimed, so that the ore lying below this ground might be recovered by the use of the old caving method. The ore is found in the Lower Carboniferous limestone, which, in the south of the property, is overlain by glacial clays and sands. Carefully controlled caving in the limestone had heretofore led merely to gentle subsidence of the impervious clays above the caved ground, danger of flooding by surface water thus being minimized. Too rapid extraction of the ore during the War period, however, when the mine was under the control of the Ministry of Munitions, had led to severe faulting of the overlying glacial beds and there had, in consequence, been several abnormal inrushes of sea-water. In another part of the mine, where the ore outcropped directly beneath the cover of glacial sediments, development of the ore-body had been frequently attended by the inrush of sand. In these two areas, therefore, some alternative method of mining had to be adopted and controlled sand-filling, in the opinion of those in charge of the property, offered the best solution of the problem. The manner in which this has been carried out will, as was previously stated, be found elsewhere and it will be sufficient to say here that most of the extraction difficulties appear successfully to have been overcome, well over a million tons of ore having thus been brought into the reserves. In his introductory remarks the author laid stress on the care which had to be taken in this work and in the sinking of the bore-holes used as sand feeders. He was also able to add some details as to costs, the absence of which had detracted somewhat from the value of the paper. He calculated that, excluding overhead charges, the actual cost of sand-filling in this property worked out at about 10d. for every ton of ore replaced, three-fifths of this amount going as wages and two-fifths for fuel and lubricants, the filling material being present in almost unlimited quantities at the surface. At the present rate of extraction this adds approximately 4d. to 5d. to the costs per ton raised. The discussion was opened by Mr. R. E. Palmer, who proceeded to compare sand-filling with hand-filling as adopted by himself in similar work elsewhere. Mr. Palmer also called attention to the merits of pneumatic stowing, which is being successfully applied on the Continent. Following Mr. Palmer, Col. Edgar Pam showed how extensively the use of sand for filling purposes had been applied on the Rand, pointing out its use in packing ground where hand-stowing would be impossible. Professor Lawn endorsed Mr. Palmer's reminder that top-slice caving methods of mining, while widely practised in America, were originally developed in Cumberland, and Mr. Whitehouse, who concluded the discussion, while differing with Col. Pam as to the wide range of application of sand-filling methods, demonstrated its usefulness in certain circumstances.

The remainder of time available at last month's meeting was occupied by the introduction and discussion of Mr. Armytage's paper on flotation details. The author describes flotation as an art, but points out that various mechanical devices can be usefully employed by the artist in order to simplify his labours, going on to say that in the production of a brittle, well-mineralized froth an expert operator will be able, owing to his experience, to produce such a froth as a result of constant observation, relying at the same time on certain definite factors. These factors, such as accuracy in maintaining alkalinity of the circuit, in the rate of reagent addition, in the sizing of the ore-particles, and in the times of contact with reagents, can be suitably controlled by the use of certain practical aids, these aids forming the main subject-matter of the thesis. The author then considers these factors in detail, concluding his paper with an essay on relative floatability. Here he points out that, while investigating a complex ore for the first time, it may be useful to fractionate the froth into a number of products, each representing the results of a two-minute bulk float of all the ore minerals, no change being made in the circuit except for the addition of the frother and collector. In this way, it is said, some idea of relative floatabilities can be gained and any unusual features will immediately become apparent. The whole presentation of the paper and the opportunity given to members at the meeting of inspecting the "gadgets" used by the author bore ample testimony to his acquaintance with his subject and of the ingenuity and the workshop handiness which are so useful in this practical-scale laboratory work. Discussion of the paper was opened by Mr. Sulman, who was able to amplify several points made by the author and to show how modern methods have brought flotation practice under more

accurate control. Other speakers included Mr. Butler-Jones, Dr. Sidney Smith, and Mr. J. C. Allan.

The third paper, by Mr. Jack Spalding—details of which will be found elsewhere in this issue—was, in the absence of the author in India, left for discussion in writing. This paper describes the chrysotile asbestos deposits at Shabani, in Southern Rhodesia, and gives details of the methods employed in mining and handling the large tonnages extracted. The geology of the Shabani belt has been fully described by Dr. F. E. Keep in his monograph appearing in Bulletin No. 12 of the Southern Rhodesia Geological Survey and Mr. Spalding's description of the deposits is based on this work. As regards the mining of the ore-bodies, however, the author was able to give the results of first-hand experience and his description covers the organization of the work and the quarrying methods, by which most of the output is at present obtained. This is followed by a description of the methods of handling the ore, the development of new ore-bodies, the stoping methods employed in the Nil Desperandum mine and modifications contemplated elsewhere, and the subsequent treatment of the asbestos mineral, concluding with an account of the general surface equipment and of labour conditions. It might be as well here to mark the care which has to be taken in treating the chrysotile ore in order to preserve the fibre in an undamaged condition and to emphasize the author's note that milling suitable at one property has often been found unsuitable for apparently similar ore from neighbouring mines. The importance of these deposits, especially when the pre-eminent position of the Empire as an asbestos producer is considered, lends additional interest to this complete description of the mining and treatment methods employed in Southern Rhodesia.

The British Industries Fair

This year's British Industries Fair was an event of more than usual importance, coming as it did at a crucial time in the economic history not only of this country but of the world. On this account it merits more attention than is usually given it in these columns, not so much by reason of its direct interest to mining men as because of the indication it affords of the probable course of British industry, which, in common with that of all other countries, has declined in consequence of certain forces that, while variously diagnosed, are generally felt to be outside industrial control. Mining men realize that their own industry is not likely to witness that prosperity enjoyed but a few years since until those manufacturing concerns which are the consumers of the raw materials produced return to normal activity. That such a return may reasonably be anticipated before any great lapse of time is the inevitable conclusion reached after an extensive tour of all sections of the fair. There was certainly one feature which distinguished this year's fair from those previously held. It has taken place at a time when the British manufacturer is afforded a double advantage—the increased purchasing power of several foreign currencies, as a result of the depreciation of sterling on foreign exchanges, following the abandonment of the gold standard by this country, attracts the foreign buyer, whilst the protection afforded by a long-awaited change in the fiscal policy protects the home industries against the influx of manufactured articles of other than British origin. That this double factor has proved a beneficial one was evidenced by the larger number of visitors from abroad and by the increased business done.

That the fair should have been so well attended—the increase is said to have amounted to over 50 per cent. as compared with last year—and have done more business is not, perhaps, surprising having regard to the causes alluded to, but that it should have presented a greater and more comprehensive display than in the past was as remarkable as it was creditable to all concerned. The Birmingham section—which is referred to in some detail elsewhere in this issue—was somewhat more extensive than last year, for, while there were some notable absentees, there were a number of new comers. Metals and the articles into which they are or can be fabricated were the principal features here. The electrical industry was also well represented and some of the heavy engineering industries, the latter not so well as they might have been. It must be borne in mind, however, that the exhibition of running plant is an expensive undertaking for the manufacturer and that there is a tendency for such to be reserved for specialized exhibitions. The running exhibit staged out of doors—designed to demonstrate the employment of excavating, transport, and

crushing machinery in contracting operations—was a notable new departure, which well deserves special commendation and, when open-air space is available—as it certainly was here—is likely to prove a useful field for extension in the future. Altogether this year's fair may be regarded, not merely as a worthy successor to those preceding it, but as a convincing demonstration of the British manufacturer's intention to overcome all the obstacles presented by an economic upheaval and of his recognition of the necessity of meeting his customers' requirements.

The Technician in Commerce

In another column an impending revival in British industry is suggested as the outcome of the impressions conveyed by a visit to this year's British Industries Fair. Another aspect of this all-important topic opportunely presents itself for discussion in the form of some reflections on the subject-matter of a lecture by Mr. W. E. Gooday, delivered last month at the Royal School of Mines, on "The Technician in Commerce." While Mr. Gooday was dealing particularly with the marketing of lubricating oils—a sphere of commercial activity of which he is specially qualified to speak—he made some observations of a general character and there are a number of points of interest to engineers and metallurgists arising therefrom which deserve examination.

As Mr. Gooday pointed out, there ought to be, and in the view of many there is, a big field of usefulness for the technically-trained man in commerce—in commerce, it should be emphasized, and not in industry, where the technician is already extensively and inevitably employed on the research and production sides. The employment of a scientifically-educated man on the sales organization is, however, relatively exceptional, but that this conception of the engineer's comparatively limited value to industry is beginning to disappear is as evident as it is fortunate. This was the burden of Mr. Gooday's contention and it is the purpose of this brief review to endorse as emphatically as possible both its truth and its importance. A similar thesis has already been admirably presented by Mr. Gilbert Rigg, the well-known metallurgist, in a fascinating story[1] of his early experiences, when, as a fully-fledged chemical engineer, he dealt with a number of commercial problems in the zinc industry, but Mr. Rigg only partially covers the subject. Thus there are broadly speaking two kinds of salesmanship—the selling of a specific product and the selling of service. Sometimes one, sometimes the other, but more often than not both are required. Mr. Rigg writes almost exclusively of service after sales, in which field of commerce the man who has technical qualifications to equip him for the task is indisputably without equal. In the other sphere also the educated salesman has become increasingly necessary and, when industry appreciates this and the young men show themselves adaptable to the special requirements of commerce, improved results are confidently believed to be a foregone conclusion.

That the foregoing remarks are not idle speculation will surely be generally appreciated. How otherwise can inefficiency in British selling methods be accounted for, except it be in the shortcomings of the personnel. It is obviously bad policy to send men to sell machinery, for example, who, when they have exhausted their sales talk, have no reserves on which to draw in order to counter informed criticism, such as may be anticipated from the potential buyer who is himself a practising engineer. And yet how often has this happened. Many who read this indictment—made in no carping spirit, but with every desire to help—will have some knowledge and experience of manufacturing works. Will they not readily agree that in too many instances there is a gulf fixed between the selling organization and that responsible for research and production? Conversation with sales managers and their executives reveals that, while they are fully conversant with their firm's products, they frequently have but a slight acquaintance with the operations for which they are designed to be used. In the absence of this knowledge, how are they to make those outside contacts that are required of them? This may seem to be a counsel of perfection, yet a change such as that indicated is surely taking place. Our younger engineers who have the requisite personality—an indefinable quality—should be encouraged to present themselves for service in engineering commerce, and industry should admit them and thus secure better relations between research, production, and sales on the one hand and manufacturer and customer on the other.

[1] The Sales Engineer: Mining Publications, Ltd.

REVIEW OF MINING

Introduction.—Sentiment in this country has, particularly during the past week or so, been cautiously optimistic and, although it is realized that it may be some time before mining affairs can expect to be favourably affected to any extent, it is hoped that the tide of depression is nearing the turning point, if it has not already reached it. The recent spectacular rise in the value of sterling is regarded with mixed feelings, for, whilst it may be taken as evidencing a revival of confidence in this country's financial soundness, it is not calculated to benefit its export trade.

Transvaal.—The output of gold on the Rand for February was 869,711 oz. and in outside districts 44,301 oz., making a total of 914,012 oz., as compared with 936,784 oz. in January. The number of natives employed on the gold mines at the end of the month totalled 216,171, as compared with 215,752 at the end of January.

The report of Modderfontein B Gold Mines for 1931 shows a working profit of £424,173, other revenue bringing the total profit up to £449,465. The total sum available was £774,147, of which £420,000 was distributed as dividends, equal to 60%, and, after making various allowances, £275,127 was carried forward. The ore-reserve position, when compared with that at the end of 1930, is not quite so good, the total at 1,177,460 tons, averaging 6·57 dwt. in value over a stoping width of 49·3 in., showing a decrease of 48,940 tons in amount, of 0·46 dwt. in value, and of 2·6 in. in width. During the year under review 887,000 tons was milled, 264,895 oz. of gold being recovered, worth £1,123,775, the revenue showing a decrease of 4s. 5d. per ton milled when compared with the previous year. Working costs amounted to £704,565, equal to 15s. 10d. per ton milled, a decrease of 1s. 1d. from the previous year's figures. It is felt that, while the present scale of milling operations will be maintained during the current year, the profit, in view of the lower ore-reserve value, will be somewhat reduced.

The accounts of Geldenhuis Deep for 1931 show a working profit of £72,351. After allowing for sundry items of revenue and adding the sum of £113,686 unappropriated at the end of 1930, the total available was £190,431, of which £56,667 was distributed as dividends, equal to 10%. After making various allowances, the sum of £118,309 was carried to the next account. The ore reserves at 654,200 tons, averaging 5·55 dwt. over 51·7 in., show a decrease of 32,700 tons in amount, of 0·11 dwt. in value, and of 0·3 in. in width. During last year 861,900 tons of ore was milled, 198,843 oz. of gold being recovered, valued at £843,603, or 19s. 7d. per ton milled. Working costs amounted to £772,718, equal to 17s. 11d. per ton. The tonnage milled was a record for the mine.

During 1931 the working profit of the Rose Deep was £30,856, the net profit being £30,372. After adding the balance of £92,462 brought in and sundry revenue, the total sum available was £122,871, of which £16,574 was distributed as a dividend, equal to 2½%. After making various allowances, the sum of £81,622 was carried forward. Ore reserves, estimated to be 1,019,800 tons, averaging 4·7 dwt. over 61 in., show a decrease of 71,500 tons and of 0·2 dwt. in value when compared with the previous year. During the year under review 741,500 tons of ore was milled, 153,029 oz. gold being recovered, worth £649,093, silver and osmiridium recovered bringing the total revenue to £650,495, or 17s. 7d. per ton milled. Working costs amounted to £619,638, or 16s. 9d. per ton.

The accounts of the Village Deep for 1931 show that the subsidiary clean-up is still proceeding, £14,284 being recovered during the year. After making allowance for the repayment of 4s. 6d. capital on each of the shares during 1931, there was a balance available at the end of the year of £79,765. At an extraordinary meeting, to be held following the annual meeting next month, it will be proposed that the capital of the company be reduced from £475,053 in shares of 9s. 6d. each to £425,048 in shares of 8s. 6d. each, by returning to the holders the sum of 1s. per share in cash.

Details of the proposed sale of the assets of the Witpoort Gold Areas to Brakpan Mines, Ltd., were given in the last issue of the MAGAZINE. A meeting of shareholders of Witpoort Gold Areas, Ltd., has been called for the last day of the present month, when they will be asked to approve the sale.

An extraordinary meeting of Moodies Gold Mining and Exploration Company is to be held in Johannesburg this month for the purpose of considering an offer to purchase made by the Transvaal Exploring Land and Minerals Company. The latter has agreed to take over the whole of the assets of the former in return for 680,000 fully-paid shares

of 1s. each. If the offer is accepted the Moodies Company will go into voluntary liquidation. The Transvaal Company has also offered to take over McCreedy Tins (Swaziland), Ltd., in return for 200,000 fully-paid shares in its own company, and at an extraordinary meeting to be held next month its shareholders will be asked to approve these two purchases, as well as the necessary increase of capital to £217,803 10s. to meet the purchase consideration.

It was announced last month that the Union Corporation intended to carry out certain prospecting work on the Marievale Nigel property.

Preference shareholders of the Consolidated Gold Fields of South Africa have been informed that the dividend on the Second Preference shares, postponed from October 1 last, will be paid on April 1 and that the dividend for the current half-year will be paid at the same time. Payment on the preference share capital of this company will thus be brought up to date.

Diamonds.—The expectation of Sir Ernest Oppenheimer that the South African diamond mines would soon be compelled to close down was noted in the last issue of the MAGAZINE and has since been confirmed by the announcement that the De Beers mines would cease work at the end of March, the decision to adopt the same course being subsequently announced by the Premier and the Consolidated Diamond Mines of South-West Africa companies. The situation thus created is said to have come as a surprise to the Union Government, which was investigating the problem, and at the beginning of March it was announced that a commission, consisting of Judge Gardiner, Mr. Ross Frames, a former chairman of De Beers, and Mr. F. W. Beyers, ex-Minister of Mines, had been appointed to investigate conditions in the industry. Advices from the Union show that the total production of stones in 1931 amounted to 2,119,155 carats, valued at £4,182,523, as compared with 3,163,590 carats, valued at £8,340,719, in 1930.

Southern Rhodesia.—The output of gold from Southern Rhodesia during January was 42,706 oz., as compared with 50,034 oz. for the previous month and 45,677 oz. for January, 1931. Other outputs for the month of January were: Silver, 25,942 oz.; coal, 47,073 tons; asbestos, 755 tons; copper, 4 tons; mica, 3½ tons; tin, 1 ton.

It was announced this month that the African and European Investment Co., Ltd., and the Lonely Reef Gold Mining Co., Ltd., have jointly acquired an option over the Charliesona mine, 12 miles due south of the Lonely mine. This property has only been partially prospected, the proved reef at 100 ft. depth having a width of 26 ft. over a length of 300 ft., the average value being between 8 and 9 dwt. The Lonely Reef company has also acquired rights over the Peter Pan ore-body, which is within four miles of the mine. Here 100,000 tons of ore, of an average value of 4·1 dwt., has been proved down to 70 ft.

With regard to the petition of the Globe and Phoenix company to be allowed to appeal against the decision of the High Court granting permission to the Rhodesian Corporation, Ltd., to make a complete inspection of the Globe and Phoenix mine, the latest news is to the effect that the right to appeal against the judgment has been refused.

Northern Rhodesia.—During the three months to December 31 last the Roan Antelope produced 7,872 short tons of blister copper, while 8,453 dry short tons of concentrates was shipped to America for smelting and refining. All production is now in the form of blister copper. Costs during the first full month's operation at the smelter—December—were £2·532 per short ton and for the quarter £2·88 per short ton of blister copper, including starting up expenses. Construction work has almost been completed and the number of both European and native employees shows a big reduction when compared with the previous quarter.

Kenya Colony.—A small gold rush has taken place to the Kakamega district, north of the Yala River. The auriferous district is said to cover an area of approximately 300 square miles.

India.—Shareholders of Balaghât Gold Mines, Ltd., have been informed that, in view of the heavy cost of deep development work on the mine and the difficulty of maintaining an adequate scale of output, the directors have approached the board of Nundydroog Mines, Ltd., with a view to that company acquiring their property.

Burma.—A prospecting licence over the Mwedaw gold area, covering a square mile of country below Kalaw, near the Southern Shan Railway, has been granted to the Kafue Copper Development Company. It is said that the existence of a gold reef in the

area has been established and development work is to commence immediately

Malaya.—The report of Gopeng Consolidated, Ltd., for the year ended September 30 last shows the profit to have been £29,251. After adding the sum brought in from the last account and making various allowances, there was an available total of £54,836, of which dividends absorbed £26,385, equal to 1s. 4d. per share, leaving £28,451 to be carried forward. During the year 1,705,600 cu. yd. of ground was treated, 719 tons of tin ore being recovered, worth £49,295. Working costs again show a reduction from 10·56 cents to 9·55 cents (2·67 pence) per cu. yd., the lowest figure attained by the company. It has been announced recently that the company has arranged to take over the quota allotted to the Kent (F.M.S.) Tin Dredging company and that consequently the dredge of the latter will not recommence production this month.

The accounts of Petaling Tin, Ltd., for the year ended October 31 last show a net profit of £29,444. After adding the sum of £26,402 brought in, the amount available was £55,846, of which £29,167 was distributed as dividends, equal to 12½%, the balance of £26,679 being carried forward. The amount of ground treated during the year was 4,054,060 cu. yd., as compared with 4,854,630 cu. yd. in the previous year, the tin recovered amounting to 1,580 tons, against 2,124 tons. The price realized for the concentrate was £102,282.

New Guinea.—Shareholders of the Oroville Dredging Company have been informed that a substantial interest has been acquired in Bulolo Gold Dredging, which owns a large area of alluvial gold property on the Bulolo and Watut Rivers.

Mexico.—The report of the Mexican Corporation for the quarter ended December 31 last shows that owing to low metal prices the suspension of sulphide ore production at Fresnillo is under consideration, while the Teziutlan property was closed down at the end of the year.

British-American Tin Corporation.—At an extraordinary meeting of shareholders of the British-American Tin Corporation, Ltd., held this month, it was agreed that the unissued capital of the corporation, amounting to £500,000, should be called preferred ordinary shares of £1 each and that the whole of the company's assets, except its stock of metallic tin, should be sold to a new company, the British Tin Investment Corporation, Ltd., in return for 1,750,000 shares of 10s. each, credited as fully paid. It is proposed that the corporation's stock of tin metal should be acquired by a separate company, Tin Holdings, Ltd., for £112,500, to be satisfied by the allotment of 2,250,000 shares of 1s. each in the new company, credited as fully paid. Present shareholders will thus receive one fully-paid 10s. share in the new investment corporation and three fully-paid 1s. shares in Tin Holdings, Ltd., in return for each share now held.

British South Africa Company.—The accounts of the British South Africa Company for the year to September 30 last show the net profit to have been £262,151, against £409,762 in the previous year, to which must be added the sum of £647,053 brought in from the previous account. A dividend equal to 9d. per share absorbed £261,720, leaving £647,484 to be carried forward. Accompanying this report is an account of mining activities in Rhodesia by Mr. E. H. Clifford, in which he notes the serious decrease in the value of the mineral production of Southern Rhodesia, due principally to declines in the coal, chrome, and asbestos outputs, owing to the depressed condition of industry. In Northern Rhodesia the curtailment of copper production has meant a slowing down of activities on the copper belt, although prospecting for other minerals has been actively continued, and a deposit of manganese ore at Luano, six miles west of N'Changa, is now being exploited to provide flux for the N'Kana smelter.

Corderoy Syndicate.—A circular to shareholders of the Corderoy Syndicate that accompanied the report for 1931 intimated that some decision regarding the future of the company would have to be made. The alternatives before the shareholders were either to take up an option over an alluvial gold area in New Mexico or that the company should go into voluntary liquidation, and the first course was approved at the annual meeting. To provide the necessary capital for the development of this area shareholders are to surrender one-half of their holdings to trustees appointed by the directors, the shares so surrendered being available for re-purchase at 1s. per share for a period of 21 days, after which they may be sold by the trustees. The property to be examined lies on the River Hondo, a tributary of the Rio Grande, and it is stated it embraces 10,000,000 cu. yd. of ground, averaging 2s. per cu. yd. in recoverable value.

THE SUB NIGEL GOLD MINE

By G. CARLETON JONES

In this article the author, who is consulting engineer to the New Consolidated Gold Fields, Ltd., in the Transvaal, describes operations at this Heidelberg district mine.

The usual article dealing with the general description of a mine lays most stress on the straight technical features involved, but in writing of the Nigel district, and of the Sub Nigel mine in particular, the author feels that there is so much of interest connected with the pure romance of the early days, which is not generally known, that an outline of the vicissitudes of those times should not be out of place.

One of the earliest and richest discoveries of gold in the Witwatersrand banket was that in the Nigel district, which followed immediately upon the startling reef discoveries near Johannesburg, upon which world-wide attention had already been focussed. In those early days it was little thought that the "Nigel" Reef, as it was then termed, belonged to the identical reef series being opened up at that time in the Johannesburg district, in fact the conception of a Witwatersrand, which would embrace the eighty-mile strip of country lying between Randfontein and Nigel was undreamt of. Even to-day the Sub Nigel mine, although exploiting the reef series which has come to be acknowledged as being the continuation of the Main Reef Series, is still excluded from the Witwatersrand district in most of the official returns and reports. It seems almost paradoxical, when considering on the one hand the rapid advance of the industry and the springing up of towns and villages along the line of outcrop, that on the other hand it has taken practically 40 years to establish the fact definitely that the Main Reef Series is continuous between Randfontein and Nigel.

Gold in the Nigel district was first discovered in a reef outcropping on the farm Varkensfontein No. 217, which was proclaimed in 1888. The property was acquired by the Nigel Gold Mining Company, Ltd., which at once commenced operations, thus becoming the first property in the Far East Rand district to produce.

General View of Reduction Works, Sub Nigel Mine.

Mining was first started in July 1888, the method consisting of blasting the ore on to sheep skins and removing the product by means of wheel-barrows or small trucks drawn by mules. The ore was then conveyed by means of ox-waggons to a five-stamp mill situated on the Blesbok Spruit, nearly two miles from the workings. The gold recoveries in the first treatments surpassed all expectations and at times showed over 5 oz. per ton for days on end. For the year 1891 the extraordinarily high average of 2·23 oz. per ton was actually obtained for 4,417 tons treated, and it must be remembered that this high recovery resulted from treatment by amalgamation only. To such an extent had public interest been aroused by this Eldorado that within a few years the ground on all sides of

Varkensfontein was also proclaimed, and "Nigel" added to the name of any proposed company was sufficient to ensure successful flotation, if the acquisition of claims within the elastic boundaries of that district was the new company's object. By 1897 thirteen different "Nigel" companies, with an authorized capital of £3,455,000 had been "floated" from the farms Varkensfontein, Droogebult, Noycedale, Bultfontein, and Marievale, besides innumerable syndicates and individual claim holders; but only three concerns came to actual production. One party of adventurers banded together to prospect for diamonds in the bed of Blesbok Spruit, indicating the unbounded faith held at that time in the possibilities of the district. Naturally such liveliness, combined with its distance from the Reef towns, tended to make Nigel village a populous centre, there being no fewer than thirteen hostelries and the usual complement of shebeens to cater for the refreshment and amusement of the community; in fact the village became a hub of activity and according to the "old timers" a very gay place indeed, compared with the quiet village of to-day.

Sub Nigel, Ltd., was formed in 1895, with a capital of £350,000 to acquire 483 claims on Droogebult. The company's activities in its early years were confined to exploring the reef by diamond drilling and to acquiring additional claim areas.

Meanwhile the Nigel Deep, Ltd., formed in 1894, and comprising 659 claims on Varkensfontein on the immediate dip of the Nigel G. M. Company's ground, was mining and producing from two shafts which had intersected the reef at depths of 883 ft. and 686 ft. At the same time the Central Nigel Deep, Ltd., beyond the Nigel Deep, had, with courageous enterprise, laid out three vertical shafts in line to intersect the reef at an estimated depth of about 2,000 ft., and these shafts had been sunk to depths of 636 ft., 1,136 ft., and 792 ft. between the years 1895 and 1899. In the case of No. 2 Shaft, subsequent operations have proved that had this shaft been continued a further depth of 920 ft. it would have intersected the phenomenally rich shoot which has now come to be known as the Sub Nigel Main Shoot. Unfortunately all shaft sinking operations were stopped in 1899, owing to the Company's funds having become practically exhausted. In 1903 a bore-hole was put down from the surface to a depth of 3,404 ft., but encountered a dyke, which is now known to be the dyke which is associated with the main divisional fault between the "C" Shaft and No. 1 Shaft area of the Sub Nigel.

Sub Nigel Mine—Sorting from Mechanical Shaker.

Had the No. 2 Shaft been continued to reef, or had the site of the bore-hole been selected a few hundred feet to the West, the main shoot of the present Sub Nigel mine would have been encountered, and it is safe to say that the development of the Far East Rand would have been advanced by at least 20 years; in fact the entire layout of the Witwatersrand might to-day have been totally different, since advancement would in all probability have been West from Nigel instead of, as has been the case, East from Johannesburg. This will be the more readily appreciated when it is realized that the Sub Nigel Main Shoot, which came

so near to being intersected at depth, has not yet been surpassed in richness anywhere on the Witwatersrand.

In 1909 the Nigel Deep, although producing, had had a run of bad luck and, through heavy faulting, was seriously hampered in its operations by lack of funds, while the Central Nigel Deep was in liquidation, without even having reached the reef. The Sub Nigel, on the other hand, had been able to conserve its resources by adopting the policy of awaiting developments on the neighbouring properties before committing itself to a production programme, although in the meantime acquiring the 175 claims belonging to the French Western Nigel from east to west over a distance of 3·8 miles in the direction of the strike, and from south to north over a distance of 4·8 miles on the dip of the reef, embracing a total area of about 10·5 square miles.

It will be seen from the foregoing that the Nigel mine, which started crushing in 1888, was the immediate forerunner of deep level mining on the Nigel Deep, which is now part of the Sub Nigel Mine. This Company, therefore, although only coming into prominence during the past few years as a leading gold producer, can really be looked upon as one of the pioneer mining companies of the Witwatersrand fields. Strangely enough the Western area of the mine, which includes

Sub Nigel Mine—Native Drilling, with Scraper in Operation in Background.

and a portion of the Nigel Deep ground, 139 claims in extent and including the "E" Vertical Shaft. Accordingly, with the help of a financial reconstruction, it was able to acquire the remaining assets of the Nigel Deep, and commenced active operations on its own account on December 18, 1909, with a total holding of 1,375 claims.

Various additional areas were taken up between 1914 and 1919, including the southern mynpacht of 500 claims on Grootfontein, which was acquired at a cost of £131,956. In 1923 various worked out and barren areas, totalling 362 claims, in the upper portion of the mine were abandoned, and in May, 1926, the lease of 2,373 claims on Grootfontein was granted to the Company by the Union Government. The area held under mining title at the present time is 4,555 claims. At its Southern end, which is the wider, the property extends the 483 claims on the farm Droogebult on which the original Sub Nigel Company was formed, was never exploited until five years ago, and then only in a minor degree by exploratory driving on the 19th level.

The main concentration of effort has been on the line of extension of the pay streaks of the Nigel mine, which have been, and still continue to be, parallel to the longitudinal axis of a sharply defined anticline, the trend of which is approximately North 30° West. In the eastern flank of this anticline occurs the clearly defined and rich pay streak which has now come to be locally known as the "Main Shoot." The persistence of this enriched zone can best be gauged when it is realized that it has been practically continuous from the surface through to the present depth of 3,650 ft., equivalent to a length on dip of over 22,000 ft., while the width of the

zone has averaged about 700 ft. A comparison between the richness of the Main Shoot and the remaining shoots of the mine is clearly brought home by figures recently taken out, which show that the Main Shoot averages 64 dwt. over a 15 in. reef width, while the remaining shoots of the mine average 35 dwt. over nine reef inches.

The history and fortunes of the Sub Nigel have always been wrapped up in the difficulties of regularly following the Main Shoot, the chief complication having been the extremely serious dislocations which have taken place through heavy faulting, the fluctuations in value being of relatively minor importance.

Pay Shoots.—The reef, which has a northerly dip, is overlain by the quartzites and underlain by the slates of the Witwatersrand Series. The width of the reef varies from a mere contact to as much as three feet and this variation generally supplies a fair indication of the value, wide reef being pay, while conversely narrow reef is found to be unpay ; this theory, however, is not infallible, and occasionally stretches of attractive looking reef are encountered which are found to be below the profitable margin, while contacts are sometimes met with which carry exceptionally high values. The gold content is not evenly distributed, but pay zones are found along certain well-defined shoots which run more or less parallel to the axis of the main Nigel anticline. These shoots are scattered over the property from east to west and are separated by large stretches of unpay rock, while in the shoots themselves unaccountable barren areas occur.

As is to be expected from the presence of the anticline, the faulting is both complicated and extensive, making it extremely difficult to put into operation any hard and fast scheme for development layout. The main faulting, which roughly resembles a badly conditioned rectangle with its major axis running approximately north and south, constitutes block faulting, the faults having throws varying from 200 to 500 ft. Within this rectangle subsidiary faulting has taken place, with throws varying from 50 to 200 ft., thus causing further complication. Dykes occurring in the mine, which are identified with the Ventersdorp and Karroo Systems, do not seriously interfere with mining operations, with the exception of a sill which occurs at depths of from 40 to 180 ft. below the reef, and which at times has been responsible for some costly development.

On the Sub Nigel some fourteen pay streaks have been exposed, and of these, as previously mentioned, the most important is that known locally as the Main Shoot. Between the 11th and 14th Levels this shoot varies in width from 600 to 800 ft., and splits up into three shoots separated by small areas of unpay ground. These shoots range in value from 200 to 500 inch-dwt. with patches of pay ground up to 1,000 inch-dwt. Between the 14th and 19th Levels the value increases, the minor shoots coming together to form a large block of highly pay ground varying in value from 500 to 2,000 inch-dwt. On the 18th Level a fault striking north and south with a throw of 500 ft. divides the pay shoot, which on the "C" Shaft side continues with a slight turn from its normal course, while on the No. 1 Shaft side the area adjacent to the fault has been heavily disturbed by a series of dip faults, associated with erratic reef widths and values. Away from the area of disturbance the shoots come together again to form a large section of highly pay ground about 700 ft. wide on the strike and extending in a compact and highly payable body as far as the 26th Level, divided on the 24th Level, but not otherwise affected by a fault having an upthrow of about 300 ft. Below the 26th Level the shoot is separated into two portions by an area of unpay ground, each portion, however, continuing to carry high values. North of this very little stoping has been done, but the shoot has been exposed as far as a strike fault below the 27th Level, by which it has been thrown up approximately 280 ft. In this developed area values range from 500 to 2,000 inch-dwt. and over. Below this fault the shoot has been encountered on the 27a and 28th Levels, the average width being 700 ft., with values ranging up to 4,000 inch-dwt., and interspersed with patches of barren ground. The Main Shoot below the 28th Level is being followed up with current development.

As in the case of the Main Shoot, all other shoots may be roughly traced from one level to another. The correlation is straightforward except in faulted or distorted areas, where a certain amount of subsidiary development is often necessary to obviate the mining of isolated barren patches.

To enable the trend of the shoots to be closely followed and the changes in value and conglomerate widths to be shown up

rapidly, special colour contour plans of both value and reef width are kept up to date at the mine. On the contour assay plan the inch-dwt. values obtained by sampling are segregated into groups ranging from low through medium to high values by means of contour lines of equal value. The direction of the observed long axis of the conglomerate pebble—where obtainable—is also indicated on this plan. On the conglomerate width plan, contours of equal widths are drawn.

These plans have proved themselves of great value when laying out the future development of the mine, as the change in direction and tenor of the pay streaks are shown at a glance.

Opening up a new stope by the old method was laborious and slow, owing to the need for clearing the tracks at the beginning of every shift to allow the passage of cars. Now the stope is immediately equipped with a scraper, and broken ore is quickly and easily scraped to a box at the bottom. When stoping commences the broken ore is thrown back into the winze or "gully" in which the scraper works. During the opening up period a considerable quantity of waste is produced, but care is taken to see that this waste is sorted and stacked for future use in supports.

When the stope has advanced approximately 25 ft. from the winze, the scraper

Sub Nigel Mine—Scraper in Operation, the Photograph Showing Methods of Hanging-Wall Support.

Mining Methods.—The general layout of the mine corresponds to modern Far East Rand practice and calls for no particular comment. There are, however, certain features of mining technique which may be of interest.

Owing to the combination of narrow stope widths and a flat dip, the efficient handling of broken rock in stopes at the Sub Nigel presents a problem of rather more than usual difficulty. The method formerly in use consisted of hand shovelling into small trucks running on stope tracks spaced 25 ft. apart on the dip, which delivered the ore to the winze, where it was transferred to haulage trucks handled by a winch. This method proved expensive on account of the large native complement and quantity of equipment required in proportion to the tonnage handled, and has lately been superseded by the "scraper" system.

line is moved to the face. The scraper winch generally cleans out east and west faces on alternate days, but in some cases three or four faces are served by one scraper outfit, and this arrangement allows a good accumulation of broken ore to be formed, with consequent improved efficiency.

Both single and tandem scraping is used, according to the length of stope to be served. The usual practice in the case of single scraping is for the lower 50 ft. of a stope to be cleaned first in order to avoid congestion of rock, which might obstruct the scraper. The gang then moves to the top of the stope and works down, cleaning the stope as it proceeds. By this method six natives on contract can easily clean a face 300 ft. long, handling 60 tons in an eight-hour shift.

Tandem scraping is used for backs up to 800 ft., shakers being used in conjunction

with the scrapers when the length exceeds 500 ft. In the latter case, the lower half of the stope is opened up first, hand lashing being used until the faces have advanced far enough to allow scraping to commence, and a shaker line is then installed in the bottom half of the original winze. Stope tracks are laid in the foot-wall on either side of the top of the shaker line and ore from the upper faces is scraped into special stope trucks and trammed across to the shaker, while ore from the lower faces is scraped down to loading platforms by the bottom

Sub Nigel Mine—Loading Drill Container at Surface.

scraper of the tandem line. Sorting boys are placed on the shaker line to remove any waste which may have escaped sorting at the face.

Turning now to support of workings, a reversion from the older method of pig-sty support to the new method of systematic concrete support has been effected and this change has coincided with the introduction of scraper lashing. It has been found that the methods combine admirably, forming one coherent system particularly well suited to the conditions of the mine. Concrete discs 30 in. in diameter and 4 in. thick are used with the usual timber capping ; these are placed 12 ft. apart on strike and dip, the scraper operating between the lines.

In order to prevent scattering of broken rock from the blast and to confine the ore to the face where it can be conveniently handled by the scraper, the waste collected during the opening-up stage is packed between the pancakes, forming a rockwall parallel to the face. As the face advances and the scraper line is moved, a new rockwall is built nearer the face of waste sorted from the ore, or, in some cases where there is insufficient sortable waste, the old rockwall is taken down, washed and re-built.

As soon as a rockwall has been moved, the area between the new and old positions is swept and washed. By this means all reef fines are recovered at the earliest opportunity, the rock broken reaches the mill as rapidly as possible instead of having a large proportion lying about in stopes, and the whole area can be abandoned as soon as it is worked out, since sweeping proceeds side by side with stoping.

It is of interest to note, and may here be quoted, that a rough estimate of the cost of tramming and shovelling shows that a reduction of about one shilling per ton has been effected since the adoption of the scraper method.

Drill Steel Distribution.—The drilling efficiency on the Sub Nigel is in the vicinity of eight fathoms per machine shift on the overlapping shift basis. To maintain this high machine efficiency involves many operating factors, not the least of which is the distribution of drill steel. When it is remembered that approximately 6,500 drills weighing 35 tons are handled in the drill sharpening shop daily, and that this large quantity has to be transported through busy shafts and levels to the many distant stopes and development ends, and that, after use, the worn steel has to be collected and transported to the surface as rapidly and efficiently as possible, it will be realized that steel distribution is one of the important administrative problems.

Briefly, the methods employed are as follows : The sharpened steel is loaded in the drill sharpening shops directly into wheeled containers, which are adapted for transport both in the shafts and in the underground haulages. The steel remains in these containers from the time it leaves the drill shops until it arrives at the underground drill house. Transport in the shaft is effected by the system devised on the Van Ryn Deep, whereby the skip or cage is removed from its frame and the container slung vertically

in its place. Unloading is carried out by the simple process of attaching a rope to the lower end of the container, which is then lowered to the station ; the rope pulls the container into a horizontal position where it comes to rest on its wheels. This operation is carried out with remarkable speed, the handling of all the steel required at Betty Shaft—about 3,700 drills—occupying only half an hour. The containers are then despatched down the incline haulages and taken off at the various levels.

On every level a drill house has been erected, which is placed in charge of a native.

Sub Nigel Mine—Unloading Drill Container Underground.

Here containers are unloaded and, after being re-loaded with blunt steel, are returned to the surface. The native in charge of each drill house keeps a record of the new steel he receives, the new steel he issues to miners on his level, and the blunt steel returned by them. Thus the foreman drillsmith, who is in charge of the whole system, is able to see daily whether every level has received sufficient steel, and whether any blunt steel is being left in the workings. In the latter case the mine captain concerned is notified and the matter is investigated. The foreman drillsmith works in close co-operation with the Efficiency Department, from whom he receives immediate notification of new machines starting up in any part of the mine.

The advantages claimed for this system of handling steel are that rock hoisting is interrupted only for a short time while lowering or raising steel, the immediate recovery of all blunt and broken drills, and economy in labour.

Ventilation.—The natural ventilation is assisted by a main 45-in. double-inlet Sirocco fan dealing with 100,000 cu. ft. of air per minute, situated on the eastern side of the mine on the 22 Level, and upcasting through "B" and "C" shafts. On the western side a 40-in. single-entry Sirocco fan is placed on the 23 North Section Level, and upcasts air through the upper workings of No. 1 Shaft, eventually discharging through the old workings of the Nigel mine. South of Betty shaft a large area, isolated from the rest of the mine by a major fault, is served by a single-entry 35-in. Sirocco fan having a capacity of 34,000 cu. ft. of air per minute. The total quantity of air passing through the downcast shafts is 142,000 cu. ft. per minute. For the ventilation of development ends booster fans and venturis are used.

Pumping.—The mine cannot be said to have a pumping problem, since the total water handled per day from two underground pumping stations amounts to the comparatively low figure of 350,000 gallons. On account of the low percentage of acidity (0·02%) all the water pumped to surface is available for use in the reduction plant.

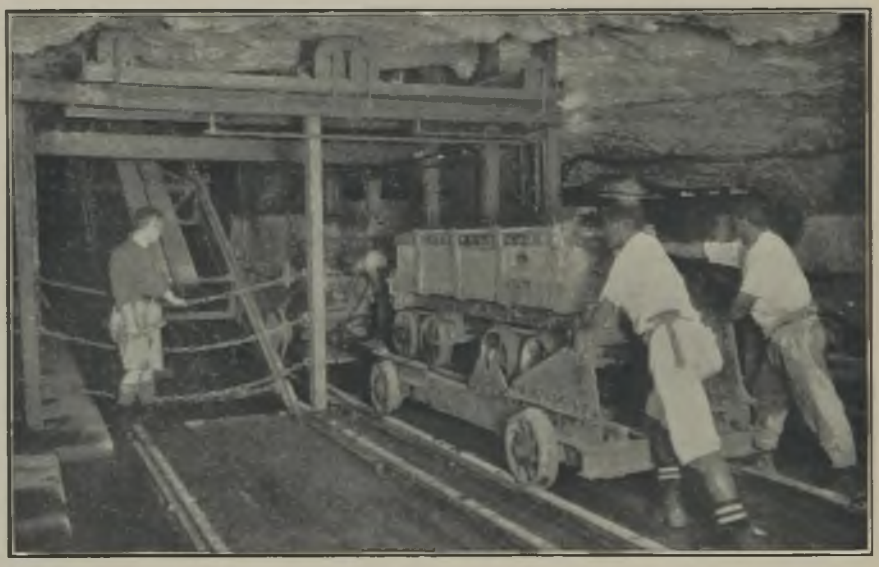
Power Plant.—The old Nigel Mine and the Sub Nigel for many years were entirely dependent on steam for power purposes, all winders, compressors and electric generators being steam driven. This has since early days necessitated the transport

of coal nine miles by road from Nigel Siding with great inconvenience at times, particularly in severe rainy weather. Serious attempts have been made in the past to urge the Railway Administration to construct a branch line to serve the property, but with no result.

With a view to cheapening power costs, the Victoria Falls and Transvaal Power Company were approached early in 1916 with regard to the supply of electric power. Towards the end of that year they agreed to instal an overhead transmission line, which was completed during 1917. The first full year's consumption was some three million units, which has grown until at the present time the annual supply is in excess of forty million units. Current is delivered by the power company at a pressure of 40,000 volts to three transformer stations situate at "C," No. 1, and Betty shafts respectively, and is there stepped down to the voltages of 525 and 2,100 for distribution to the main points of consumption.

Practically all plant and machinery is now electrically operated. No. 1 Shaft is provided with an electrically-driven geared winder capable of raising four tons of ore, which has recently been improved by the addition of contactor control gear to effect smoothness and ease of operation in starting and stopping. The rock hoist at the Betty Shaft is arranged on the Ward-Leonard system with direct coupled d.c. motor of 1,100 h.p., current being supplied by conversion through a motor-generator set of 1,750 k.w., d.c. continuous rated capacity. The rock load is six tons, raised at a maximum winding speed of 3,000 ft. per minute. The skips at this shaft are equipped throughout with ball bearing wheels and tipping rollers, and it is the intention to adopt this type at all other shafts as opportunity presents.

The compressed-air supply-mains of the Victoria Falls Company do not extend to the Far East Rand, so it has been necessary for the mine to instal and operate its own compressor plant. All requirements are supplied by a number of Belliss & Morcom direct-connected electrically-driven compressors situated at "C," No. 1, and Betty Shafts. The distribution system is interconnected both on the surface and underground, so that trouble developing at any point in the system can readily be isolated.

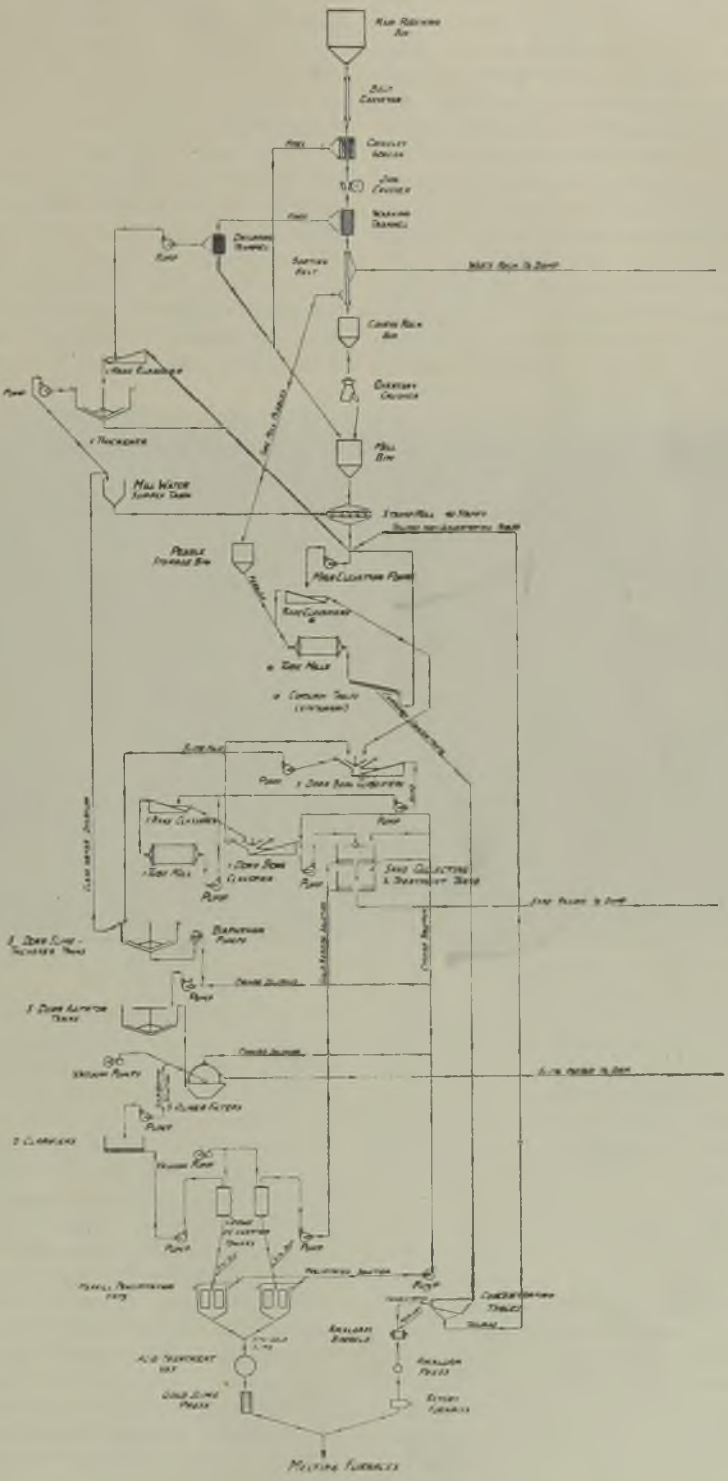


Sub Nigel Mine—Attaching Drill Container (on Special Carriage) to Skip in Incline Shaft.

The reduction plant is operated entirely by electric power; the battery and tube-mills were originally driven by a horizontal steam engine through a line shaft, but each unit is now separately driven by a 200 h.p. motor.

Ore Treatment Plant.—The reduction works are located at "C" Shaft, the ore from No. 1 and Betty Shafts being hauled in 11-ton side discharge hoppers by steam locomotives on 30 lb. track laid to 2 ft. gauge.

Six years ago the tonnage being treated in



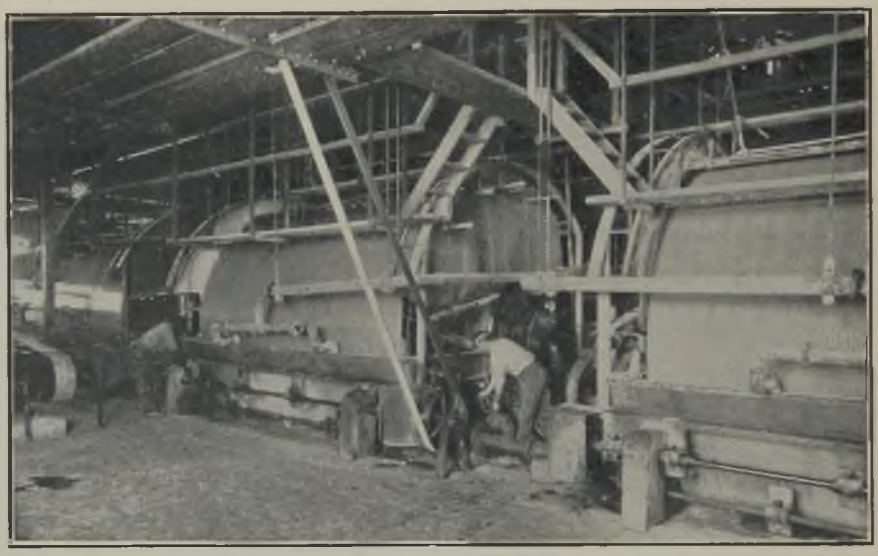
FLOW-SHEET OF REDUCTION WORKS, SUB NIGEL MINE; MONTHLY CAPACITY, 36,000 TONS.

the reduction plant was about 11,000 tons per month, and the average grade was 12·5 dwt. per ton. At that time the plant consisted of thirty stamps and two small tube-mills, and roughly 50% each of sand and slime were produced; the gold recovered was equivalent to 96% of the ore value.

During 1927 plant extensions to give a monthly output of 20,000 tons were completed; in 1928 further extensions were made bringing the capacity to 25,000 tons per month, while additional units in 1930 and 1931 progressively brought the capacity of the plant to 30,000 and ultimately 36,000 tons per month. These successive extensions

sent to the waste dump. The washings from the large trommel, after removing coarse grit in a draining trommel, are pumped to the reduction plant, where after classification and thickening they join the main grinding circuit.

When milling at the rate of 36,000 tons per month the total tonnage delivered from underground to the sorting and crushing plant is about 43,000 tons, from which approximately 15 % of waste rock is removed by picking on the sorting belt. Of the total tonnage delivered about 64% or 27,500 tons per month is minus 1½ in. ("fines"), which, after separation, is conveyed direct



Sub Nigel Mine—Portion of Oliver Filter Plant.

followed at close intervals as a result of the constantly improving position underground. It will be realized that to increase and modernize a reduction plant which was built before the Anglo-Boer War, and at the same time maintain and increase the rate of production, has been somewhat difficult.

The accompanying flow-plan will give a good general idea of the present treatment arrangements. The coarse ore (plus 1½ in.), having been separated on a grizzly and a vibrating screen, is thoroughly washed in a large revolving trommel, in order that quartzitic waste, shale and reef may be readily distinguished. It is also important that adhering fine material, which is invariably of high value, be completely removed from the waste rock before the latter is picked off the sorting belt and

to the mill bin; from the remaining 36% or 15,500 tons, approximately 6,500 tons of waste is separated by hand picking.

The assay value of the waste has been the subject of some investigation, and it has been shown, in spite of the high value of the ore, to be under 0·4 dwt. per ton. On the whole, sorting requires much closer supervision than on most mines, and receives the continuous attention of the underground staff. Independently of the abnormally high reef value there are other factors requiring periodical close investigation. At times the shale foot-wall takes on a yellowish tinge close to the reef contact and may then carry exceptionally high values. When this is known to occur as indicated by samples taken underground, one of the underground officials, with special experience of this feature, takes charge of the actual sorting

for the time being. Quartz stringers, although normally barren and sorted as such, sometimes carry excessively high values in free gold and similar sorting arrangements then need to be made as in the case of yellow shale.

In addition to waste, suitably sized pieces of ore for use as grinding load in the tube-mills are also picked from the sorting belt, and these are stored in a separate bin. The ore remaining on the belt after sorting out waste and tube-mill pebbles, is crushed down to minus 2½ in. and then passes to the main conveyor delivering fine and coarse ore to the stamp mill bin.

The next stage of crushing is effected by the 40 stamps, which have a running weight of 1,650 lb. each, and crushing through coarse screening, have a duty of 27·5 tons per day. From all sources, including ore used as tube-mill pebbles, the rate of crushing is about 1,200 tons per day. The stamp mill product, together with the outflow from the primary tube-mills is elevated by pump and distributed to six rake classifiers from each of which the rake product gravitates to one of the six tube-mills for primary grinding. In order to assist primary tube-mill grinding some locally made forged steel balls are used in addition to large ore pebbles. The partially ground pulp discharged from the mills is diluted slightly and passed over corduroy tables in order to recover free gold. The corduroy concentrate is removed by washing, is then re-concentrated on a Wilfley table and the rich concentrate is amalgamated in barrels, while the table tailing returns to the main circuit. The amalgam is retorted and melted into bars of about 890 parts fine gold per thousand. The gold recovered by concentration represents 48% of the ore value. A small amount of osmiridium concentrate is also separated during clean-up operations.

The tailing from the corduroy tables joins the main pulp-stream and is re-elevated to the tube-mill classifiers. The overflow from these classifiers is the finished product of the primary circuit. It is re-classified in bowl classifiers in order to separate the portion which still requires further grinding; a secondary grinding circuit consisting of one tube-mill, elevating pump and classifier, which receives the sand product from the bowls, has been introduced recently in order to obtain a finer product for cyanide treatment. The overflow from this circuit is re-classified in a separate bowl classifier, the fine sand product from which is pumped with cyanide solution to the sand treatment tanks, while the bowl overflow joins the stream entering the three large bowls and the overflow from these is pumped to the slime plant. The following grading analyses are of interest :—

Product.	+ 60	−60 + 90	−90 + 200	− 200
Stamp Mill Pulp	79	4	5	12
Combined Final Pulp to Cyanide Plant	—	1	22	77
Sand Product	—	8	75	17
Slime Product	—	—	15	85

Approximately 11% of the total tonnage is treated in the sand plant and 89% in the slime plant. The treatment of the cyanide pulp as one product (so-called " all-sliming ") has not been introduced for two principal reasons; first, unlike new plants, which have recently been built, sand collecting and treatment tanks have always been available at Sub Nigel, and secondly, provided the grinding is sufficiently fine, a lower residue is obtained from the high value sandy portion of the pulp by giving it the benefit of the longer treatment with cyanide solution, which is possible in that section of the plant.

The slime is collected in five 50 ft. by 12 ft. continuous collecting tanks from which the thickened pulp with a specific gravity of 1·6 to 1·62 is pumped after dilution with cyanide solution to the first of five 50 ft. by 12 ft. Dorr Agitators. These are arranged in series, the pulp flowing by gravity from the first to the last; the pulp during agitation has a specific gravity of 1·32 to 1·34. From the last agitator the pulp again flows by gravity to five Oliver continuous filters in which the gold-bearing solution is removed. The residue cake is discharged on a conveyor belt, thence into a re-pulping tank, from which it is pumped to the residue dam; some gold-bearing solution is recovered from the dam.

Before precipitation the filtrate solution is clarified by passing through sand filters or is re-used in the early stages of the sand treatment. All solution for precipitation is de-aerated by the Crowe process and the gold is precipitated on zinc dust in the latest type of Merrill plant (filter frames suspended in tanks). Twice per month the accumulated precipitate is washed off the filter frames and pumped into acid-treatment vats. The resultant gold slime is filter-pressed, calcined and smelted, bullion bars of 880 to 890 gold fineness being obtained.

New Recreation Hall, Sub Nigel Mine.

The average value of the total ore sent to the treatment plant after the removal of waste rock is about 17·5 dwt. per ton, and the total residue (sand and slime combined) is 0·4 dwt. per ton, so that the total extraction by concentration and cyaniding is equivalent to 97·7% of the original ore value.

Working Cost.—In comparison with the mines of the Witwatersrand the working cost per ton milled at the Sub Nigel is substantially higher, the figure for recent months having averaged approximately 35s. for this mine as compared with 19s. 3d. for the Witwatersrand. This relatively high cost on the per ton basis is due to certain factors peculiar to the mine, these being :—

(*a*) High development charges, due to low tonnage developed per foot advanced.

(*b*) Narrow stoping width.

(*c*) High cost of claim licences and other standing charges.

Of these factors the most outstanding is the cost of development, which is approximately 11s. per ton milled as compared with an average figure of about 2s. per ton for the Witwatersrand as a whole ; this high cost is chiefly due to the small tonnage developed per foot advanced. A comparison of the footage advanced per 1,000 tons milled for the past financial year gives 154 ft. for the Sub Nigel, as against 37 ft. for the whole of the Witwatersrand. Breaking and lashing costs are naturally high on a per ton basis owing to the excessively narrow stoping width.

The normal crushing rate of 36,000 tons per month compares with an average figure of about 87,000 tons for the 31 producing mines of the Witwatersrand and this low tonnage imposes a big handicap on working costs per ton milled in respect of standing charges, such as claim licences, insurances, administration expenses, etc. In claim licences alone, on account of the extensive area held, the figure is 7d. per ton higher than the average for all other Reef mines.

The following is a summary of results to June 30, 1931, including the operations of the Nigel Deep from its inception up till the time of its absorption by the Sub Nigel :—

Tons Milled	3,226,954
Yield (fine ounces)	2,286,200
Revenue from gold	£9,932,036
Working Expenditure	£6,344,660
Working Profit	£3,587,366
Less other expenditure after allowing for sundry revenue, interest, etc., received	£153,152
Nett Profit	£3,434,214
Distributed in Dividends	£2,660,282

The amount expended on exploiting the entire property, including amounts spent in developing the individual properties finally acquired by the Sub Nigel, Limited, totalled £2,164,152 at the end of June, 1931.

In conclusion it can be claimed that only by dint of great perseverance, continued faith in the ultimate possibilities of the district and the application of modern mining methods has it been possible for the Sub Nigel to attain its present satisfactory position. For the year 1930 the mine ranked second amongst the world's principal producers in yield of gold per ton crushed, sixteenth in order of total gold produced and tenth in profits earned.

BUCKET DREDGE LOSSES

By T. L. WILLAN, B.Sc.

The author presents certain factors which govern the loss of values in Eastern bucket-dredging practice.

The monthly records of recovery of Eastern Companies operating bucket dredges are read with interest by engineers and investors throughout the world. The dredge losses, although equally interesting, are, as a rule, not recorded, and in many deposits are not investigated. In the course of his Eastern experience the writer has investigated, by means of boring, a large number of alluvial properties, mainly in the Malay Peninsula, in which the aggregate depths of bores drilled reached some 90 miles. The study of the properties —comprising about 700 million cubic yards of dredgeable ground—which are now equipped and producing as a result of the boring, and the investigation during recent years of these and many other areas, now partly dredged, have yielded much interesting information concerning the efficiency of bucket dredges as means of recovering minerals, such as tin oxide, gold, etc., from alluvial deposits. In the present state of our knowledge, dredge losses are somewhat more difficult to estimate than the actual mineral content of the ground, and a few general notes based on the results of the writer's experience in that rich and very interesting region — the Malay Peninsula—may be of interest.

Bucket dredging is admittedly one of the cheapest and most reliable methods of alluvial mining, and in the case of low grade ground in flooded areas or tidal estuaries is perhaps the only possible method of mining. The bucket dredge, however, although the product of many years of study and experience, is still an imperfect machine and requires great care on the part of its designers before its erection in the field and in some cases careful adjustments afterwards. The Eastern dredging industry has made rapid progress during the past decade and, whereas dredges of small capacity, digging perhaps 80,000 cu. yd. a month to maximum depths of 50 to 60 ft., were common a few years ago, we now have quite a number of bucket dredges with proved digging capacities of 200,000 to 300,000 cu. yd. a month. Also digging depths of 70 to 80 ft. are now common in Malaya and several dredges with maximum digging depths varying from 100 to 120 ft. below water level are in operation. Apart from the rather general adoption of jigs in preference to launders the principal improvements in the industry have been in dredge capacity and in reduced costs per cubic yard. In achieving an improvement in capacity, however, improved tin saving appliances and great care in dredging have been necessary in order to prevent increased losses.

The general nature of bucket dredging losses is perhaps well-known, but the amount and the economic importance of the losses in individual properties are not always appreciated owing to the difficulty, and perhaps the cost, of estimating the amount of loss. Bucket dredge losses may be divided roughly into several classes of varying importance according to the nature of the deposit and the type of dredge used, namely :—

(*a*) Losses due to failure to dig the lower layers of wash.

(*b*) Losses of lumps of unwashed mineral-bearing sand and gravel due to insufficient washing in the trommel.

(*c*) Losses due to bucket droppings of sand and gravel newly dug.

(*d*) Jig or launder losses.

(*e*) Losses in the oversize material discharged from the screen.

The first mentioned loss is, of course, unavoidable in deposits overlying hard limestone bedrock, owing to the interference of the irregular bottom with dredging operations. To determine the significance of this factor is by far the most difficult task which confronts the engineer who is called upon to estimate the value of alluvial ground in limestone country, as so much depends on the details of the geological structure of the alluvial deposits and the nature of the solution channels in the limestone bedrock. Although it is possible by a careful study of a deposit of this type to estimate fairly accurately the recovery with a given type of dredge, it is well to remember that the interference of irregular bedrock with the dredging of the lower layers of wash is a factor which alone renders many areas of moderately rich alluvial ground unsuitable for bucket

dredging. On the other hand, other areas of similar grade, but with more favourable vertical distribution of values, may be mined economically by bucket dredging in spite of very irregular hard bedrock. However, losses due to the failure of the bucket dredge to dig the lower layer of wash are not confined to deposits overlying irregular limestone bottom. The less marked irregularity of the soft bedrock surface in many soft bottom areas, the presence in some cases of a layer of boulders immediately overlying the soft bottom, combined with insufficient care in dredging, are factors which sometimes result in considerable quantities of payable ground being left undug.

The importance of a loss of this description may be imagined when one considers that in some soft bottom areas as much as 80 to 90% of the tin (or gold) in the ground is contained in the one or two feet of wash immediately overlying the decomposed bedrock. The realization of the importance of considerations of this nature in actual dredging is indicated by the confirmation of the writer's boring results by dredging operations in the case of Kamra Tin Dredging, Ltd., as recently announced by the Chairman at the annual general meeting. In this case the careful policy of the management in digging several feet of the soft bedrock underlying the wash to make certain that all the rich wash is dug is largely responsible for the dredge output approximating so closely to the writer's estimate of recovery based on the results of boring.

Investigations of dredge losses conducted by means of launder tests and boring of the tailings in a number of dredging properties have indicated the following conditions :—

(*a*) In some soft bottom areas the dredging has been so carefully done that practically no rich wash has been left undug and the launder losses are so small that it is not feasible to consider the redredging of such areas even with large capacity dredges.

(*b*) In other cases investigated, in some of which the ground would be suitable for redredging, a very large percentage of the richer ground has been left undredged owing either to the failure to dredge the alluvial wash in channels in the soft bottom or to the failure or neglect to dredge beneath the large boulders immediately overlying the soft bedrock.

(*c*) The valuable alluvial ground left undug after dredging deposits overlying irregular limestone bottom may be sufficient to pay for retreatment of large areas by gravel pumping or hydraulicking and cases are known where open cast mining with efficient tin saving appliances has recovered twice as much tin oxide as a dredge working in similar ground.

(*d*) Ground may also be left undug owing to the insufficiency of the power provided for digging. For example, in some regions residual areas of older felspathic alluvial deposits exist beneath the more sandy deposits of tin-bearing wash immediately underlying recent flood plain (overburden) deposits. Although the overburden and sandy wash in such cases is very easily dug, the digging of these stiff older deposits, which often contain much decomposed felspar (clay), of comparatively low water content, may require so much power that the monthly capacity of a large dredge capable of mining the more sandy deposits at a good profit may be reduced to such an extent that mining is unprofitable if the digging of the underlying older deposits is attempted. In such cases quite considerable losses of valuable tin-bearing ground may be necessarily entailed by working such a dredge at a profit in the freer upper deposits and the redredging of considerable areas with more powerful dredges may be feasible. In places where there is no free wash overlying the stiffer formation, insufficient digging power may result in the capacity of the dredge being so low that dredging in the older deposits is only profitable in high grade ground.

(*e*) Losses of lumps of undisintegrated "karang" due to insufficient washing in the trommel are sometimes quite considerable when dredging older and stiffer deposits of the type above mentioned and careful boring in the dredge tailings in one area of this type revealed that, whereas jig losses were almost negligible, about 25% of the "karang" (or tin-bearing ground) dug passed through the trommel unwashed.

(*f*) Various devices, more or less effective, have been used to reduce the loss due to droppings from the buckets and it would appear that, although losses of this type may be extremely large in poorly-constructed dredges, with a well-designed dredge actual losses due to this factor may be reduced almost to a negligible quantity.

(*g*) There has been at times a good deal of controversy concerning the relative efficiency of jigs versus launders and, while continuity of operation and the relatively lower cost of operating the jig are advantages in its favour, jig losses may be quite as high with poor distribution and inefficient supervision as launder losses with inefficient launder coolies. An improvement in the method of distribution in large capacity jig dredges has been known to increase the average extraction of the jigs by four to five per cent; on the other hand, jig losses may be increased considerably, especially in the case of the clean-up jigs, as a result of choking of the jig beds. The raking of the latter by hand or by mechanical means of some sort would appear to be as necessary in dredges equipped with jigs as the raking of launders by coolies in the launder dredges. The amount of slime in the paddock water is another factor which tends to increase jig or launder losses if uncontrolled and careful boring in the tailings in some areas has indicated that, although most of the ground dug has been thoroughly disintegrated and washed in the trommel, the amount of clay slime (or decomposed felspar particles in suspension) in the paddock water has been increased to such an extent that jig and launder losses have amounted to as much as 30% of the tin content of the ground.

(*h*) Lumps of tin oxide too large to pass through the holes in the revolving screen are frequently lost by dredges operating in ground containing much coarse tin and overloading of the screen in sandy ground may result in smaller grains of tin oxide being discharged with the excess of sand passing through the trommel. In some cases lumps of unwashed interbedded clay or soft clay bedrock are instrumental also in carrying valuable minerals to the tailings dump.

UGANDA

By E. J. WAYLAND, A.R.C.Sc., M.I.M.M., F.G.S.

(*Concluded from the February issue, p. 93.*)

The peneplains are helpful to the geomorphologist because the inclination of their surfaces is indicative of past movements, and it is significant that investigations, so far as they have gone, appear to indicate that the upward rise of the plateaux towards the western rift varies as their age; Peneplain 1 being the most tilted, and Peneplain 3 the least. They are of value in two other ways. They provide building material, for the ironstone can be easily hewn into blocks and, as the blankets have been partly formed by upward enrichment, they have a porous leached zone beneath them which, in places, contains sufficient water to provide small though useful supplies during droughts.

The peneplains are not confined to Uganda, indeed, they stretch at least from The Transvaal to Abyssinia, and the importance of this tableland topography was commented upon in the "Report" of the Commission on the Closer Union of the Dependencies in Eastern and Central Africa. It is not too much to say that the influence of the tablelands in the human history of the continent has been, and still is, a controlling one.

It is clear then, that the elevation and warping of Peneplain 1 produced results of profound importance; results whose effects are still with us. The new gradients, thereby introduced, engendered consequent streams which, so far as Uganda is concerned, ran in general from east to west and thus impressed upon the country a superimposed river pattern that has persisted to this day, in spite of altered and even contrary conditions of drainage necessitated by later movements. The larger of these westerly flowing streams probably rose in what is now Kenya Colony, and ran right across an area destined in later times to become the site of Lake Victoria. Moreover, they continued across the zone subsequently occupied by the Western rift valley, and so, in pre-rift days, joined the Congo system which debouched then, as now, into the Atlantic. The Congo of those days appears to have been more like the Orange River, the trunk of a westerly flowing system the upper reaches of which lay well to the east of the continent. Indeed, Mr. Combe, of the Uganda Geological Survey, contends that some of the head waters of the ancient Congo rose near the site of what is now the eastern rift in Kenya Colony.

With the elevation of the peneplain some warping was inevitable, and thus, perhaps,

some small internal basins were formed, at any rate one such basin came into being, but since it was in some measure associated with the vulcanicity that eventually built up the great mass of Mt. Elgon, which borders on the Eastern rift, it is not impossible that the basin was one of subsidence rather than of warping. In this basin accumulated a series of sandstones and conglomerates belonging to the lower part of what is called the *Bugishu Series*. They have yielded a number of plant impressions, the age of which is in process of determination. The main Bugishu sandstone outcrop lies a few miles to the south of Mbale in the Eastern Province, and would provide good building stone. Its surface appears to represent that of Peneplain 2 now downtilted to the north. The only other known deposits (apart from some others about Mount Elgon) which probably belong to this age are some poorly developed sandstones and conglomerates near Napak on the Teso-Karamoja border, north of Mt. Elgon, and some scattered plateau gravels.

During the period of quiescence that followed the uplift, the river valleys widened and their streams were graded to base level; then, about late Oligocene times, movement was renewed on a grand scale. The rift valleys and Lake Victoria began to appear. It is not altogether improbable that the Eastern is somewhat older than the Western, and there is some evidence which suggests that both rifts were re-expressed rather than originally formed at this time. The foliation and mylonization that one finds increasingly pronounced as the rifts are approached, in some places, is hardly likely to have been a surface effect of compressional faulting in Tertiary (and specially late Tertiary) times; and just as it can be shown that lavas have been periodically extruded on the eastern side of Lake Victoria during and since pre-Cambrian days, probably from beneath the site of Lake Victoria (a fact that seems to indicate that the lake site overlies a dynamic centre of very long standing), and because some sort of genetic relationship between the lake site and rifts in Kenya and Uganda is evidenced by their relative dispositions, together with the fact that large inland basins seem to have been in the (more or less) periodic order of things in the heart of Africa since time immemorial, it is not altogether unreasonable to suggest that the original rift faults are long pre-peneplain in date and were re-expressed at surface in Tertiary times. On this hypothesis, pre-Tertiary rift valleys might well have been topographically obliterated by peneplanation, so that there is no knowing what sediments, if any, underly the Tertiary and Quaternary deposits which were laid down in the re-expressed rifts, nor, assuming their presence, what their thickness may be. It is even possible, though admittedly far from probable, that marine accumulations may be represented. The known thickness of Tertiary deposits in the Albert rift does not exceed 2,000 ft.,

Fig. 10.—Kegezi Smiths at Work.

but it does not appear that the whole succession is exposed. In some places, it is certainly much less, while in others it may well be much more. Locally, as in parts of the Semliki valley, for example, subaqueous deposits appear to be missing.

The Albertine succession, as developed near the northern nose of Ruwenzori at any rate, is twofold. The lower part though containing argillaceous members, is essentially a series of sandstones and conglomerates, and is known as the *Kisegi beds*, while the upper part, the *Kaiso beds*, though containing arenaceous members, is essentially an argillaceous series. In the south, at any rate, there appears to be an unconformity between them. At the local base of the Kisegi deposits at Kibuku, on the western side of the northern nose of Ruwenzori, there is a green pebble bed which owes its colour to iron phosphates. It is soaked with petroleum ; and a sample taken at the outcrop, and doubtless somewhat inspissated, proved to have a specific gravity of 0·906 at 15·5° c., and a flash point of 114° c. More or less petroliferous horizons occur in the Kisegi beds, especially towards the local base, and carbonaceous material occurs locally. Selenite is of common occurrence and nontronite occurs. The Kaiso beds carry one or more lignite horizons in their lower half. In quality they compare with the sub-bituminous coal of Udi, Nigeria, and an approximate analysis gave the following result :—

Moisture (at 105° c.)	18·59
Fixed Carbon	27·01
Volatile matter	35·26
Ash	19·14

An attempt to extract soluble hydro-carbons resulted in the recovery of a reddish-brown brittle solid, resembling resin, in a quantity amounting to 11·6 lb. per ton. The lignite is extremely friable, and would need to be bricquetted before use. It has not received much attention in the field because up till now its position has rendered its exploitation uneconomic. The extent of the deposits is unknown. Further north, near Kibero, another oil seepage occurs (Fig. 15). It differs from that of Kibuku and may well be coming from another horizon, perhaps in the Kaiso beds from which series the seepage emerges. It has soaked the shore-sands of Lake Albert in its vicinity, and the inspissated surface material proves on analysis to have the following characters.

Fig. 11.—Gneissose G2 Granite, near Lake Karenge.

	%
Petroleum (soluble in acetone)	56·8
Asphaltine (soluble in chloroform)	42·5
Ash, and non-bituminous organic matter	0·7
Sulphur	0·31

Calorific value, 10·332 small calories, or 18·598 B. Th. U.

When dried the oil has a specific gravity

of 0·916 at 15° c., and on distillation yields the following :—

Fractions.	*Boiling points.*	*Yield %*	*S.G. at 15° c.*	*Bromine absorption.*	*Flash point.*
Light Petroleum	Up to 150° c.	1·1	—	60·5	—
Kerosene	150°–300° c.	12·4	0·835	42·5	60° c.
Lubricating oils and hydrocarbons	Above 300° c. at 300 mm.	56·5	—	—	—
Coke and Pitch	—	30·9	—	—	—

Another oil seepage has lately been discovered near Butiaba, and a small intermittent seepage occurs in the saline hot springs at Kibero. Several are known on the Belgian side of the lake.

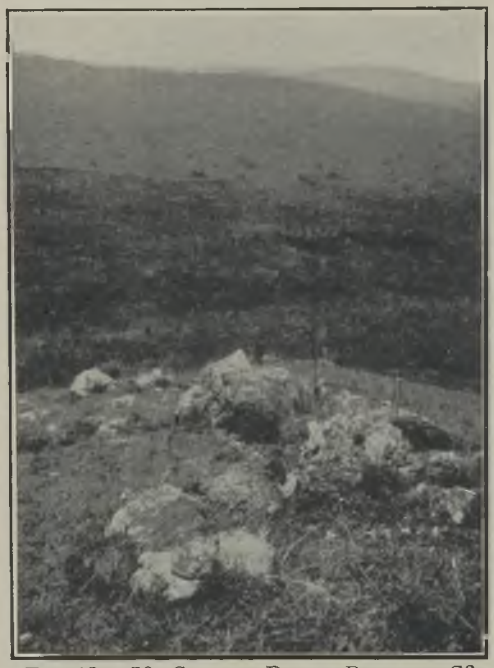


Fig. 12.—G3 Granite Dykes Piercing G2 Granite on a Hillside, Lake Karenge.

The Tertiary sediments of the Albertine depression contain, at and near their top, fossiliferous ironstone horizons (Fig. 16). which have yielded many bones. These are largely phosphatized, and are indicative of fauna containing a high percentage of extinct forms. They are, nevertheless, dated as middle Pleistocene. It is not improbable that prolonged search would reveal human remains among them, for a primitive artifact was found which almost without doubt came from the bone-bearing deposits.

Associated with the bones of terrestrial mammals are those of crocodile, hippopotamus, and fishes ; and molluscs are of common occurrence. The ironstone horizons represent shallow pools brought into being by the desiccation of Lake Albert. The Tertiary sediments dip, for the most part, at very low angles towards the lake ; though locally, moderately high angles are known. In certain areas the dip of the beds turns over scarpwards as the scarps are approached, the scarpward dip being higher than the lakeward dip ; and here and there, there are domoid structures, one of which, the Waki dome, near Butiaba, has been, and still is, the subject of discussion from the point of view of oil exploration.

The Quaternary deposits, especially in relation to the drainage systems past and present, are deserving of study by the mining man, for bound up with their distribution and history is the problem of the existence and whereabouts of alluvial deposits ; and one of the striking facts about the mineral exploration of Uganda is the failure to find such deposits in areas where their occurrence might well be expected. The hydrography of the Protectorate is unusual. Looking first at Lake Victoria ; clearly it displays in its highly indented drowned coastline all the features of modernity. Yet we know by the existence of ancient lacustrine deposits in Kavirondo (Kenya Colony) that its history dates back to the Miocene. It must thus be at once one of the oldest and one of the youngest great lakes in the world. To the north of it lies an astonishingly branched water-system usually known collectively as Lake Kioga, which receives the waters of Lake Victoria and transfers them to Lake Albert, one of several great lakes lying at the bottom of the Western rift depression. Lake Wamala (W.N.W. of Entebbe) is another, though much smaller, lake of the Kioga type, and there are several others, still smaller, of the same kind. The lakes of the south-west which owe their origin to the damming of erosion valleys by lava flows, have already been mentioned and, in addition to these, there are some highly interesting swamp-lakes, or large swamps, each situated about 25 miles from the Western Rift scarp and at the headwaters of oppositely flowing streams, those flowing more or less to the east being in general sluggish swamp-rivers and those flowing to

FIG. 13.—THE SURFACE AT MWIRASANDU TIN MINE; THE HEAPS OF MATERIAL ARE COMPOSED OF ELUVIAL TINSTONE, HAND-GATHERED FROM THE SOIL.

the west becoming rapidly flowing affluents to the rift valley. But there is more than this, for not only does such a river as the Katonga (to select one example) suggest by the orientation of its tributaries and the existence of its through-valley from a lake of higher altitude (Victoria) to one of lower altitude (George) that its direction of flow is westward throughout, which we have just seen it is not, but inspection of the map reveals that the eastern tributaries of the Katonga have been invaded by Lake Victoria, whose remarkably indented coast is thus discovered to be consequent upon the drowning of river valleys. It is this which shows the lake to be younger than the rivers, and provides a clue to the significance of Lake Kioga and the swamp lake divides.

Clearly Kioga, Wamala, and others of their type are valley systems drowned because of an easterly downtilt, or a westerly uptilt, or both, over an axis upon which the swamp-

FIG. 14.—PENEPLAIN 1 AND A REMNANT OF PENEPLAIN 2, THE LOWER GROUND PASSING INTO PENEPLAIN 3. THE HILLS ARE COMPOSED OF BUKOBA SANDSTONE.

lake divides are situated. At right angles to this axis, however, there has also been movement which, relatively or actually, has been downwards to the north-east, and upwards to the south-west. Part of the evidence for this is provided by the reversal of the Kafu River and the continuation of its flow, with that of Lake Kioga, along a once southerly feeding tributary (the lower Victoria Nile) which now spills itself, by way of the Murchison falls, into Lake Albert ; and part of the evidence, though this is not all, is provided by the hanging base. The hanging base is a line along the eastern escarpment of Lake Albert above which the scenery hangs and below which the scarp

FIG. 15.—PETROLEUM SEEPAGE, NORTH OF KIBERO, ON LAKE ALBERT : THE FIGURE IN THE FOREGROUND IS STANDING ON OIL-SOAKED BEACH SAND.

falls more or less sheer (Fig. 17). This line declines in altitude from the south-west to the north-east. Its want of obliteration indicates the comparative recentness of the movement that produced it, and the evidence of perched lake deposits in the lower Muzizi valley, the history of the Kaiso bone-bearing beds, and the tilted terrace gravels of the Kafu show that this occurred at the earliest in middle-Pleistocene times. So far as the Albert valley is concerned, the movement took place along pre-existing faults which may have come into being in about Oligocene days ; but more probably (the writer thinks) were rejuvenated at that time. The evidence as we have it at present indicates that this great Pleistocene movement took place during the second of the two Pluvial periods that occurred in Quaternary times and it was this movement, or group of associated movements, that accomplished the river reversals already referred to, and added Lake Victoria, as a great reservoir, to the Nile system at a time when the encroaching desert was making much of Egypt uninhabitable to Palæolithic man. But for this event, the history of Western civilization might have been different. Lake Victoria, as we have seen, started in a small way in Miocene times, since when it has expanded, largely by Westerly encroachment. That much of its area was already sufficiently low-lying to accommodate a vast lake in Pluvial 1 times (early Pleistocene) is evidenced by high-level gravels and silts that indicate flooding into the old valleys, but as a permanent lake of its present size and form it is no older than middle Pleistocene.[1]

All this is very interesting, but the practical miner need not be told that it is of more than academic significance, for clearly it has a direct bearing on that important procedure, the search for possible placers. It is useless to explore upstream for lodes whose detritus has been distributed in another direction, for their discovery, except by pure chance, will not be brought about thereby. Similarly, sluggish rivers that have done little by way of erosion, and that little by moving and redepositing pre-existing alluvials, are unlikely to contain valuable concentrations, unless conditions

[1] It is not impossible that the supposed Miocene may, after all, turn out to be Pleistocene (*vide Nature*, vol. 129, Jan. 2, 1932).

for re-concentration have been unusual and remarkably good ; and thus it would appear that, speaking generally, the best chance of the discovery of placer deposits in mineralized areas is in pre-reversal gravels, in what is now a downstream direction. The value of this procedure in application was proved by the Geological Survey's work on the Kafu gravels, already referred to. Unfortunately, however, the gold values were too patchy to make extraction profitable, but there is still a chance that useful deposits may exist in that area and may yet be discovered by methods indicated by the study of past drainage. It is not true, of course, that all the major stretches of the rivers have been reversed, for (to take an example) while the present lower course of the Kagera in Uganda has suffered reversal, its approximately south to north stretch in Tanganyika maintains its old direction. The Aswa, too, in the north, has most probably always been a north-westerly flowing stream. Nor, so far as it is known, have the post-middle Pleistocene water courses undergone inversion.

The case of the West Nile district is worth considering. This area lies on the eastern side of the Nile-Congo divide. Gold is widely distributed on each side of the divide ; indeed, almost every stream contains the metal, a quite unusual state of affairs for Uganda. But whereas on the west side payable deposits, if only in the form of one-man propositions (some large and famous fields exist, of course) are of common occurrence, continued prospecting has failed to reveal a single deposit worth exploitation, even as a one-man proposition, on the eastern side. The solid geology does not appear to be entirely responsible for this state of affairs.

The writer has watched with interest the careful and protracted efforts of competent prospectors and mining engineers to discover alluvial and lode deposits in the West Nile, and from a consideration of these and of his own investigations, has arrived at the conclusion that the prospecting of water courses either upstream or downstream will not be productive, except by accident, in this area. The present streams are, nearly all of them, very juvenile and have had no history to speak of ; but the state of abrasion of their gravels is incompatible with modernity. Much of it is second or third cycle, if not more antiquated material, derived from pre-existing deposits, and the gold has been brought in with it and not re-concentrated. If there are any placers in the West Nile they belong, not to the present or the older levels of the present streams, but to an entirely different and pre-middle Pleistocene drainage system. The only sound method of prospecting the area is to employ geological methods and to determine what the early drainage was and to follow up the gold in the usual way. There is, for example, an old and well-marked beach some 500 feet above the Nile. There may be a higher one, but assume that this is the topmost : A careful study of its pebbles and their horizontal grade changes should lead to the discovery of the now

FIG. 16.—IRONSTONE HORIZONS IN THE KAISO BEDS.

extinct streams or rivers which supplied them, and this, together with the gold content from place to place, should reveal salient facts; while an aerial survey of the area will (as the writer knows, having flown over it) throw much light on the positions and courses of the ancient channels. The geological survey proposes to carry out work on these lines in 1932.

Gold is reported in several places in this part of the Nile valley. It is known to exist on the eastern side of the river (East Madi), and the black sands found on the shores in some places along the river yield a little of the metal, sometimes as much as four pennyweights per ton.

Of considerable interest are the recent saline crater lakes of Busongora lying between Lakes Edward and George, and Ruwenzori. They contain very large supplies of salt, and potassium is present in marked amount. One of these lakes (Katwe) is the site of a native managed industry. About 1,000 tons of salt are sold per annum, entirely to natives. This lake, like some others in the district, is much below the level of Lakes Edward and George, and its surface appears to be that of the water table; for while it does not oscillate with the sunspot cycle, as the great Equatorial lakes do, it rises and falls, through a vertical interval of not more than a foot, not without lag, in accordance with seasonal variations of rainfall. The salt, it would seem, is brought to the surface by convection currents consequent upon temperature gradient established by a heated plug at no very great depth. Petrographical and geochemical investigations by Professor Holmes and Dr. Harwood go to show that in all probability these crater lakes overlie Kimberlite pipes in depth.

Numerous other economic minerals are known to occur in small quantities, and some may yet prove to be of economic significance. A short account of these will be found in "*The Summary of Progress*" of the Geological Survey of Uganda, 1919–1929, printed by the Government Printers, Entebbe, Uganda. It may be remarked in passing that the Birunga volcanic field, part of which is included in Uganda, contains what is probably the largest leucite bearing area in the world, and is thus a great, though at present commercially inaccessible, reserve of potash.

FIG. 17.—LAKE ALBERT, NEAR TONIA, SHOWING THE HANGING SCENERY OF THE BUNYORO ESCARPMENT.

TECTONICS.—The tectonics of the Protectorate provide important, complicated, and interesting fields for investigation and are deserving of a long paper entirely to themselves. No attempt will be made to deal adequately with them here. Some aspects of the problems they raise have been lightly touched upon in the foregoing pages and little will be done to amplify the subject in this paper.

The relationship of mineralization to N.–S. and E.–W. (approx.), fault lines in Bunyoro has already been mentioned, and it seems probable that the auriferous quartz dykes of the impenetrable forest are related to N.W.–S.E. fracture planes. Certainly it is an important strike direction of folds in that area and is a trend line of importance elsewhere. The remarkably sharp turn of the Nile below Nimule and the continuation of that line in a south-easterly direction by

the Aswa River is strikingly brought out on the map. By projecting that line, which along the Nile and the Aswa is known to be a fault or shatter zone with crushing, it will be found to run under the south-western part of Mount Elgon, and to run into the fault of the Nandi escarpment. Near Elgon, in this vicinity, a little gold is known to occur, but it has not been proved to be related to N.W.–S.E. fractures, though faulting is known to occur. But a similar shatter-zone in Southern Kavirondo (near the Gori River, in Kenya) provides lenticular quartz bodies which are being worked for gold. The Aswa fault is worthy of investigation from the point of view of the possible occurrence of mineral deposits.

Water Supply.—Several references to this extremely important subject have already been made (*vide supra*) and further accounts will be found in the "*Summary of Progress*," already mentioned, and in Dr. Dixey's new book ("A Practical Handbook on Water-supply," 1931). References to the possibilities of sandstone areas, dolerite sills, and the perched water-tables beneath the lateritic ironstones, have already been made. Faults plugged with breccia might, in some areas, be found to bank up subterranean supplies, and the usual controlling conditions of ground-water reservoirs will be found to obtain in different districts. Over the greater part of the Protectorate, however, structures associated with a lithology that might be expected to lead to true artesian conditions are wanting. It is by no means improbable, however, that they may exist in the south-west. Generally speaking, hand dug wells as a source of permanent supply are failures in Uganda, but there are, of course, exceptions, and where overground sources are inadequate, supplies have to be sought in depth by means of the drill. The tapping of a supply by that method nearly always depends upon striking a joint below the saturation level. The quantity of such a supply cannot, of course, be foretold with any degree of certainty, for, as yet, insufficient bores have been put down to provide a foundation upon which to base reasonably reliable predictions.

As already pointed out, a study of the lateritic ironstone, provided it is not drift material, will reveal the nature of the rocks beneath, and the presence or absence of dykes, etc., and so assist one in the choice of a well site. Other things equal, the thicker the ironstone cap the better the chances of good water supplies beneath, for the thicker the porous zone, which contributes water, by way of joints in the live rock, to the saturation reservoir. In drift covered (lateritized) granite country, such as parts of the Eastern Province, one has little to go on except the scanty information provided by widely scattered outcrops; and the striking of joints within a reasonable distance of the surface becomes very largely a matter of chance. A well sunk under these conditions in a country which is extremely

Fig. 18.—The First Drilled Well and Windmill Pump in Uganda, at Katakwe, Eastern Province.

arid in the dry season (at Katakwe, between Soroti and Napak) yields 30,000 gals. per day. The first bored well in Uganda was put down, and the pumping plant (a windmill) was erected by the Geological Survey (Fig. 18).

The foregoing account is sketchy and slender. Even so, it could not have been written had not a very great deal of the research upon which it is founded been carried out by others. I refer, of course, to my colleagues, present and past on the Geological Survey, and in particular to Mr. W. C. Simmons, Mr. A. D. Combe, Dr. A. W. Groves, Dr. K. A. Davies, Capt. S. Gill, and Mr. T. Hirst, whose enthusiastic labours and loyal co-operation have always been a source of great satisfaction, benefit, and pleasure to the writer.

The I.M.M. Benevolent Fund

In response to the appeal of Mr. Hugh F. K. Picard in the last issue of the MAGAZINE the following subscriptions to the Benevolent Fund of the Institution have been received :—

S. J. Truscott	£10	10s.	0d.
A. J. Bensusan	£5	5s.	0d.
W. Pellew-Harvey	£5	5s.	0d.
G. B. Bixby	£2	2s.	0d.
J. C. Tonkin	£2	2s.	0d.
THE MINING MAGAZINE	£10	10s.	0d.

BOOK REVIEWS

The Study of Rocks. By Dr. S. J. SHAND. Cloth, octavo, 224 pages. Price 6s. London : Thomas Murby and Co.

This small handbook aims at giving a concise account of all classes of rocks, without special reference to any particular country. Each chapter is concluded by a summary and a short list of selected works that will be found extremely useful to the student. Special attention is directed to the wider aim of petrology as indicating the changes which are taking or have taken place within the Earth's crust. An appendix on the chemical analysis of rocks will be of interest to those so fortunately placed as to be able to use it.

In 1927 the author published a treatise on the eruptive rocks, in which he suggested a new method of their classification based upon the degree of saturation of the same with certain minerals. This work was extensively reviewed in the August issue of the MAGAZINE of that year. Chapters II–VIII of the book under review contain a very brief account of the larger work. There is much to recommend the author's views, but it is doubtful if his classification attains the end he had in view, namely—the simplification of rock nomenclature. One feels too that he stresses too much the alteration of composition of a magma by absorption of wall rock. In the majority of igneous contacts it is surprising the small amount of evidence of such action.

Chapters IX–XIII treat of the sedimentary rocks and here follows the orthodox practice. The remainder of the book deals with the metamorphic rocks, which are divided into three classes :—e.g. mylonites, hornstones, and crystalline schists. The latter include the gneisses, which are subdivided into groups determined by the ratio of the alumina to the bases. In an elementary treatise of this character this classification has much to recommend it. Much of this section appears too advanced for a book of this standard. Some account of regional and contact metamorphism might have been added.

The book is a thoughtful and useful guide and will be of considerable help to students and mining engineers in their studies of the rocks in the field. Its conciseness is a great point in its favour.

ERNEST PARSONS.

Engineering Geology. By H. RIES and T. L. WATSON. Fourth Edition. Cloth, octavo, 728 pages, illustrated. Price 25s. New York : John Wiley and Sons. London : Chapman and Hall, Ltd.

The fourth edition of this well known work contains a number of additional references and those referring to books have been corrected to show later editions. There has also been added a chapter on the geology of reservoirs and dam sites, which is identical, word for word, with the corresponding chapter appearing in the second edition of the smaller work "Elements of Engineering Geology" by the same authors. As was the case in the smaller work, this chapter has apparently been added after the rest of the book was set up in type and the pages are numbered 446a to 446t. The last chapter—on historical geology—is also identical with the corresponding chapter in the smaller work. The book is an improvement on the preceding edition, and needs no further recommendation beyond the fact that it has run into a fourth edition.

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 4.

Nigel Area.—The recent acquisition by the Oceana Consolidated Development Company of an increased interest in the farm Eendracht No. 267 has drawn attention to an extension of Far East Rand activity, following upon the increasing operations in the neighbourhood of the Sub Nigel and

upon the excellent development results obtained in the Sub Nigel itself. It seems likely that the Nigel Reef over the whole of Eendracht lies at a depth not greater than between 4,000 and 5,000 ft., and it has been suggested that the obvious policy to be adopted for the property in the circumstances is an amalgamation with one nearer to the outcrop, such as was proposed in connexion with the adjacent farm Spaarwater and its neighbouring claim area towards the outcrop, Maraisdrift. It has been pointed out that the remarkable developments that have been in evidence in the further extensions of the Far East Rand have been largely due to the practical proofs that have been obtained in various mines in that area of the prevalence of a system of fairly high-grade shoots. It is not unlikely, that at least a modified system of shoots, as compared with those partially mapped out towards the north-east of the ground in question, will be found to exist as the properties there are opened up. Nor is it unlikely that the beginning of such a system may be found later on in the deeper workings of the East Rand Proprietary Mines.

West Rand Consolidated.—Sinking of the West Rand Consolidated Mines' South shaft was commenced on the last day of the old year and it is anticipated that the work will be completed at a depth of 4,200 ft. in March or April, 1933. It is proposed to make this shaft the sole means of hoisting Main Reef ore from the entire property, thus shutting down the East and West shafts, which will be used for ventilation and, if necessary, the lowering and raising of men and material. The bringing into commission of the new shaft will have a beneficial effect on handling charges of the ore sent to the mill and also improve ventilation. The shaft is to be used for the development of the Main Reef Series from the 27th level to the 40th level, and will be connected by means of a cross-cut with the Battery Reef Series. On the 32nd level a rock tunnel will be driven in the foot-wall of the reef from boundary to boundary and will be equipped with a trolley wire system of electric locomotive transport. Similar rock tunnels will be repeated every four levels below. From the 40th level to the southern boundary two sub-incline shafts will be sunk to develop the ground in the extreme southern section of the mine, both of which will deliver to the new vertical. The completion of this shaft will practically mean the end of all major expenditure on capital account and will allow the mine to carry on uninterruptedly with the mining and milling of the ore, of which it has over 40 years' supply.

New Hydraulic Process.—The Barberton District Alluvials Company has secured the right to work a special process for treating alluvial or similar ore-bearing deposits by hydraulic means within a radius of 75 miles from the town of Barberton. The area thus covered is an extensive one, stretching into the Lydenburg district in one direction and into Swaziland in the other. Concentration of the gravel will be carried out roughly by means of rotary washing machines, the material afterwards being sized into nine different grades, each of which will be fed separately to one of a series of seven hydraulicking tubes.

Rhodesian Copper Mines.—Retrenchment in the Northern Rhodesian copper-fields has reduced the number of operating mines there to two—the Roan Antelope and the N'Kana. Under the restriction agreement which came into effect at the beginning of this month only 3,600 tons of ore a day are now being treated in the field.

Geological Survey.—Dr. A. L. Hall, assistant director of the Geological Survey, is retiring from the position after 29 years' service. Dr. Hall received his academic education in the Universities of Bristol and Cambridge, and was senior science master at Dulwich College before his arrival in South Africa, early in 1903, to take up the post of second field geologist on the Transvaal Geological Survey, where his colleagues were Dr. E. T. Mellor and the late H. Kynaston. Shortly after Union, Dr. Hall was promoted to the position of assistant director in the Union Survey. He is a Fellow of the Geological Societies of London and South Africa, as well as of the Royal Society of South Africa, and holds the degrees of Master of Arts and Doctor of Science in the University of Cambridge. As General Secretary he was largely responsible for the organization of the International Geological Congress, which held a most successful meeting in South Africa during 1929. Dr. Hall, who is a Murchison medallist of the Geological Society of London, is well known as the author of a large number of memoirs and other contributions to the economic and general geology of South Africa.

BRISBANE

January 26.

Progress at Mount Isa.—Mr. J. P. B. Webster, director of Mount Isa, Ltd., Mining Trust Ltd., and New Guinea Goldfields, when in Brisbane last month after visiting Mount Isa, expressed great satisfaction at the progress made at the mine, which, he said, was rapidly fulfilling expectations in regard to production and metallurgical results. He predicted that the output for December would reach the record figure of 3,500 tons of lead bullion; the official return for that month, just published, shows the actual production to have been 3,502 tons of lead. Mr. Webster added that the company is extending the whole plant, so as gradually to bring the production to 5,000 or 6,000 tons monthly. The new sintering plant, constructed in Australia, is now being erected and will shortly be in operation. Orders for additional steel work have been placed in Brisbane, and the general manager (Mr. J. Kruttschnitt) hopes to have constructed in this country practically the whole of the new smelting plant, the designs for which have already been completed. As a general principle, it is intended to increase the whole plant still further for a yet greater production.

Mount Isa Output.—The total value of the bullion produced at Mount Isa since June 8, when its production began, is £301,409. Of the ore raised, 60% came from the Black Star lode, 35% from the Rio Grande, and 5% from the Black Rock. Production last month came chiefly from the glory-holes and stopes from the Lawlor (Rio Grande) section. The pyritic ore-body at the 350-ft. level in this section is being operated on, and used in the sintering process at the smelters. At the Urquhart (main haulage) shaft, the tail-track drive is still idle owing to an inflow of water. The Black Star drilling campaign has been completed and only one drill is now at work operating on the Crystallene lease, testing the southern Mount Isa area. Throughout the holiday season the men worked continuously except on Christmas Eve and Christmas Day.

Queensland Mineral Production.—Although complete returns are not yet available, it is evident that last year's mineral output in Queensland will be a substantial increase over that of 1931. Thanks to the intense prospecting carried out as a result of assistance given by the Government and the unemployment relief scheme in vogue, the gold production, although still small, is about double that of 1930. Minerals other than gold or coal have had a great lift by the production that began at Mount Isa about the middle of the year, and which has since been gradually increasing. For the nine months of the year these minerals totalled in value £235,404, which is nearly £50,000 more than the return for the like period of 1930. Of the 1931 product, the Cloncurry field produced lead (solely from the Mount Isa mine) to the value of £88,221, compared with nothing for the 1930 period, and silver worth £29,211, against £231 in the nine months of 1930.

Mount Morgan's Position.—At the annual meeting of Mount Morgan, Ltd., held last month, the chairman (Mr. J. H. Kessels) explained that the small loss incurred in the working of the mine on a limited scale was attributable almost entirely to further falls in the price of copper. The average price realized for the product shipped amounted to only £42 1s. 11d. a ton, compared with £65 11s. 8d. for the previous year. The most important section of the present company's project is the mining and treatment of 664,000 tons of readily accessible gold ore along the Linda level. Samples of this ore already tested has given highly satisfactory results. Mr. Kessels announced that important and encouraging negotiations are on foot either for raising the necessary capital to commence large-scale operations immediately or for an outright sale of the company's assets.

Newnes Shale Oil.—It has been authoritatively stated that within a year Newnes, in New South Wales, will be able to supply the whole of the gas oil requirements of the Australian Gaslight Company, totalling 2,500,000 gallons. A quantity of 60,000 gallons has already been delivered. It has also been reported that the Vacuum Oil Company has offered to take the whole of the output of power kerosene and other refined oils produced at Newnes and that negotiations are proceeding following on the offer. It is considered that before long the company at Newnes will be in a position to become a serious competitor with overseas companies.

Broken Hill Associated Smelters.—The Broken Hill Associated Smelters, Port Pirie, South Australia, continued operations in its last financial year on a basis averaging about two-thirds normal scale. This limitation was due to the reduction of ore deliveries from Broken Hill, where production has been

restricted owing to the low prices of metals. In the six years ended June 30 last the total production of marketable lead has averaged 161,666 tons a year, while during the same period £110,000 has been spent annually on alterations and improvements to the smelters. These include extensive changes and additions in the ore-handling system and in the treatment plants, while work is still in progress at the refinery, which is being reconstructed to adapt the equipment to the efficient operation of the new continuous processes. The advances made in the metallurgical processes are claimed to be of the utmost importance to the lead-mining industry.

Revival of Bendigo.—The historical Victorian Bendigo goldfield is apparently on the eve of a revival. New life has been there put into the mining industry by increased prospecting and fossicking, aided by Government funds, by the resultant improved gold yield, the increased price of gold, and the gold bonus. Money is now said to be available for mining on a larger scale. The Central Red, White, and Blue mine, which started in 1912 and paid £150,000 in dividends on an expenditure of £33,000 supplied by calls, has been refloated by Melbourne investors, and work has already been commenced by the new company. The adjoining mine (Lansell's Little 180), at one time, when worked by the late George Lansell, one of the most profitable ventures of the field, has also been taken over by investors, while yet another company, formed in Melbourne, expects to start operations within a month on the Monument Hill mine, one of three leases which were acquired after a report on the holdings had been furnished by a special committee appointed by the Federal Government. At the same time what is believed to be a new reef, 8 ft. wide, is reported by a Bendigo prospector to have been discovered by him on the fringe of Whipstick, towards Kamarooka. The reef is only 2 ft. below the surface, and it is reported that the finder dollied 4 dwt. of gold from a piece of stone weighing 1 lb.

Guinea Gold Company.—At the half-yearly meeting, held in Adelaide, of New Guinea Gold, N.L., which has a large shareholding in Bulolo Gold Dredging, Ltd., the chairman of directors (Mr. C. V. T. Wells) stated that the hull of No. 1 dredge had been floated, and that the erection of the superstructure was proceeding. Much of the machinery of both dredges had been increased in size, so as to make it conform, as far as possible with what would be used on some deeper dredging ground being developed by the parent company, Placer Development, Ltd., on the adjoining property. The directors, he added, were in negotiation with the Placer Development and Bulolo Company to determine the extent to which Guinea Gold would participate in the proposed additional areas by reason of the inclusion therein of the northern Bulolo leases originally acquired by the company.

IPOH

February 12.

Holidays.—The Chinese New Year holidays are now just over and it is to be recorded of the observances this year that, although there has been a general stoppage of work, comparatively little has been seen in the way of celebration otherwise and there is a notable reduction of the cracker firing by which, formerly, the New Year was always greeted. An increasing proportion of Chinese now follow the calendar of the Western nations, and begin their year on January 1 as we do. The Chinese have maintained a custom of squaring up financially at the end of each year and, to assist in this admirable, but now difficult purpose, the Government have issued new rules, dated January 21, to permit "any Chinese producer, not being a registered exporter, who has completed the production and sale of his quota, at any time before March 1, 1932," to sell to the Straits Trading Co., or the Eastern Smelting Co., Ltd., the whole or any part of the half monthly average of his quota, that he is permitted to have in his possession at the end of the present quota period. The amount sold in this way is to be endorsed on the Certificate of Production, and the quantity so recorded will be deducted from the quota for the next ensuing quota period. It will be seen that practically this applies only to Chinese producers, and to the smaller ones among them. So far the total quantity of ore dealt with under these new rules is surprisingly small, but there may be more done, within the limited total permitted, before the end of February.

Sub-Leases.—A new definition of the meaning of Section 38 of the Mining Enactment 1928, relative to the registration of "further sub-leases," has been issued by the Government, and is welcome as a step towards the simplification of titles over

mining land, and the reduction of parasitic claims upon the actual miners. It is now definitely laid down that after January 1, 1932, only a first sub-lease and one further sub-lease in respect of any land alienated for mining will be accepted for registration by the Land Office.

British Exporters.—Exporters to Malaya have now a great opportunity to recover ground lost during the recent years in which American and Continental machinery for mining, especially oil engines, has gained a very wide popularity; and a most valuable field for use of their products has been taken advantage of by others. For attainment of the best results it must be realized that agents, who are generally mechanical engineers and salesmen of machinery, may not always be represented in their correspondence by persons really acquainted with the conditions under which in such a field as this the machinery has to be employed. Only a mining engineer can say whether the plant is really suitable for the particular services and conditions involved, and these services and conditions, obviously, must vary greatly. In the case of the larger European mines, plant is usually selected by the company's general manager, but much mining plant is purchased by Chinese miners, and they have often in the past been lavish and even extravagant in outlay without attaining the results desired, because purchases were made by the "taokays" themselves or by even less qualified representatives, for whom the commission obtainable on a purchase might be no small factor in the selection.

New Regulations.—During the first six months of operation under the Restriction Enactments the officials, and others associated in the work with them, gave fair and full consideration to many special cases and thereby gained a large measure of public confidence in the application of the new regulations. Within the last two quota periods it has been realized that miners for whose benefit certain provisions had been made were using some facilities for other purposes than those for which they were designed and the application of rules has been tightened up. In a few cases it would appear that the manner or the sense in which rulings have been applied are not quite reasonable and these have been the subject of representations. It is considered that an assessment having been approved to a miner using his plant on one unworked part of his holdings should be equally available on exhaustion of that part for production from any other part of the same total area of contiguous small portions all held by the same producer, as the subdivisions have no real significance now, if they ever had any.

VANCOUVER

February 9.

Prospecting Activities.—A large amount of attention is being given to the possibilities of lode gold mining. Records of past production are being searched and there is hardly any prospect upon which a promising gold content has been reported that is not being investigated. In this work, the larger operating companies are equally active with the individual prospector. Under these circumstances, it is natural that prominence is given to every item of encouragement, but, nevertheless, there are some outstanding examples of success attendant already upon this campaign of exploration. Placer mining also has been stimulated and a new array of prospectors armed with gold pan and shovel and recruited largely from the ranks of the unemployed, is in the field. These men need every encouragement that they can get and it is felt in some quarters that they are handicapped unduly by the existing regulations affecting the export of gold.

Phillips Arm.—The arrangements that have been completed between Alexandria Gold Mines and the International Mining Corporation of New York, provide for an expenditure of $12,000 upon further development of the Alexandria mine on Phillips Arm. If the results of this work, which is to be completed within a period of three months, are satisfactory, a mill with a capacity of 100 tons per day is to be erected forthwith.

Bridge River.—The rapid expansion of the Pioneer mine in the Bridge River district is reflected in a recent statement of earnings. At the present rate of production the net yearly income is placed at around $400,000 as compared with approximately $75,000 a year ago. An even more striking feature is the heavy outlay on development and new equipment that is being provided for out of earnings and by means of which output is estimated to be trebled during the current year. The vein which has been proved to maintain its width and grade over a length of more than one third of a mile, is opening

up well in depth and the new equipment is designed to carry development to the 3,000 ft. level. With the completion of the 100 ton treatment plant at the Lorne mine and immediate commencement of milling operations, a great amount of attention is being focussed upon this neighbour of the Pioneer on Cadwallader creek. A great deal of valuable information has been secured recently with regard to the ore occurrence, upon which hopes are entertained of possibilities in connexion with the development in depth of other veins on the property.

Nelson Area.—Another property, which, like the Lorne mine, was a victim of the ill-conceived activities of Stobie Forlong and Company in boom days, is the Yankee Girl in the Nelson area. This mine is now being re-opened by Messrs. Crawford and Weeks, who were identified with its former operation. Prior to the disastrous speculation in which claims were staked on the other side of the mountain to cover mill and tunnel sites with the idea of driving a long cross-cut to open up the ore bodies at considerable depth, the mine had shipped about 58,000 tons of ore averaging approximately 0·5 oz. gold, 3 oz. silver, 32% lead, and 38% zinc, from ore-shoots occurring in a system of fissuring in tongues of granite, intrusive into schist, and developed to a depth of about 1,200 ft. Title to the claims covering ambitious camp buildings and works, and the portal of the cross-cut tunnel which was driven for a distance of about 2,800 ft., not much more than half way to its objective, has now lapsed, and the original mine claims have reverted to the owners from whom the present option is held. It is planned to resume operations along the same conservative lines that were successful in the past, with a view to outlining tonnage to warrant erection of a treatment plant.

Boundary.—In the Franklin camp, near Grand Forks in the Boundary district, milling operations have been commenced on the gold ore discovered recently at the Union property. The new ore-body encountered in a faulted position in the upper levels of the mine carried streaks of exceptionally high-grade ore on both foot- and hanging-wall and shipments of the crude ore have been made to the Trail smelter, the first carload having a value of around $45,000. Wilfley tables have now been installed and concentrate assaying $12,000 per ton is being shipped to the Department of Mines at Ottawa for treatment and refining of bullion. The property is being operated by the Hecla Mining Company of Wallace, Idaho. This company became interested in the camp in the year 1927 and, while attention was devoted principally to the development of ore-bodies on the Union group, options on neighbouring properties were also acquired. One of these groups, adjoining the Union on the north, is the Maple Leaf, where platinum values have been recorded associated with lenses of chalcopyrite in a pyroxenite formation. The bond that was held originally by Hecla Mining Company upon this group was dropped, but has now been re-established on the basis of a considerably higher valuation. This action by the company is viewed with great satisfaction as guaranteeing sustained operations in this field.

Britannia Beach.—The report of the Howe Sound Company, of which Britannia M. & S. Co., Ltd., is the principal subsidiary, provides figures of considerable satisfaction in regard to the operations at Britannia Beach. The value of all metals produced during the last quarter of 1931 is given as $1,388,749, operating costs being $1,347,245. While the income of $41,504, thus represented, is not wholly in relation to the Britannia mine and shows, naturally enough, a decline as compared with previous periods, it may be considered remarkable that operations of such a character as are conducted at the Beach, can be covered with a statement of profit. This result is due to the wonderful efficiency maintained at Britannia, where, during 1931, an amount of approximately 2,000,000 tons of ore averaging not much more than 1% copper and with a very low gold content, was passed through the mill with an ultimate recovery of about 31,000,000 lb. copper, 5,300 oz. gold, and 143,000 oz. silver. Apart from the record that has been established in regard to low operating costs, the conduct of operations, and the policy adopted by this United States-controlled company, reflects the highest credit upon the management. In the purchase of supplies, for example, upon which account an annual amount of approximately $1,000,000 is incurred, it is stated that preference is always given to British Columbian or Canadian products, while the staff is recruited almost exclusively from Canadians, a goodly proportion being graduates of the University of British Columbia. It is gratifying to note the confidence of this company in the

future, as expressed in the active prosecution of development work, including the driving of a 10,000 ft. haulage tunnel from the millsite, to tap the 60 odd miles of the underground workings of the mine.

TORONTO

February 17.

Porcupine.—The gold mines of this area during January produced bullion to the value of $1,571,971, from the treatment of 274,095 tons of ore, as compared with $1,572,678, from 252,324 tons of ore in January, 1931. The preliminary statement of the Hollinger Consolidated for 1931 shows bullion production valued at $10,528,864 as compared with $10,263,525 in 1930. Income from investments and so forth was $622,370 as compared with $639,436, making a total income of $11,151,234, as against $10,902,951. Operating costs were $7,464,744, as compared with $6,319,049, leaving net profits before depreciation of $3,684,490, as compared with $4,083,382. Dividends were $3,444,000, and the net surplus before depreciation was $242,490. The tonnage treated during the year was 1,640,705 tons, as against 1,625,868 tons, and the recovery per ton was higher at $6·41, against $6·31. The ore reserves stood at $46,241,688, as compared with $48,806,685. Dome Mines, Ltd., according to a preliminary statement for the year 1931, obtained a total bullion recovery of $3,486,506 from the treatment of 542,600 tons of ore, recovering an average of $6·42 per ton. Operating costs were $1,889,201 and, after deducting $180,921 for taxes, there remained a net operating profit of $1,416,384. Non-operating income of $274,411, brought the total up to $1,690,824. The mill is now operating at the rate of 1,500 tons per day. Further changes in the mill equipment have been found to be necessary to prevent loss in tailings and a special equipment has been ordered for heating the air going into the Pachuca tanks, which, it is believed, will prove effective. The McIntyre Porcupine has been steadily increasing its output, its gross income for the three months ending December 31 amounting to $1,464,352, as compared with $1,277,232 for the previous three months. The net earnings for the last quarter (before depreciation) were $671,490, as compared with $543,597. Underground development, is understood to be increasing the ore reserves, the old mill is being dismantled and, although no official information is available, it is believed that an important addition to mill equipment is in contemplation. The Vipond Consolidated during the three months to December 31 treated 24,925 tons of ore and produced bullion to the value of $135,512, with a recovery of approximately $5·48 per ton. For the full year the company produced approximately $580,000, compared with $919,000 for 1930. An extensive programme of underground work is being carried on in search of new ore-bodies and, while results have not been altogether satisfactory, some indications of good ore have been encountered. The report of Coniaurium for the year 1931 shows gold production of a gross value of $735,708 from 130,585 tons of ore, with a recovery of $6·02 per ton, as compared with $736,727 from the treatment of 122,972 tons in 1930. Despite the increased earnings the company had a deficit of $62,826. Development at the lower horizons has shown further improvements in ore widths and values are also improving. New equipment has been ordered to carry the workings to deeper levels. The Canusa has made good progress in its development programme and obtained favourable mineral showings. It is proposed to sink the shaft to a depth of 1,000 ft.

Kirkland Lake.—The output of Kirkland Lake mines for January from 118,793 tons of ore was $1,991,993, as compared with $1,649,438 for January of last year when 128,477 tons were milled. The Lake Shore Mines, Ltd., for the three months ending December 31 reports bullion production of $3,230,000—an increase of $549,241 over the $2,780,759 for the preceding quarter—from the treatment of 212,650 tons of ore, with a recovery of slightly more than $15 per ton. During the time the mill operated at a daily rate of 2,400 tons and on some occasions reached as high as 2,600 tons daily. The management has planned for active development this year and shaft sinking is well under way for the opening up of new levels. The work on the present bottom levels shows that the ore-values are holding up well and in some instances show improvement. Wright-Hargreaves is making good progress with its enlarged programme of mine development and it is expected that the shaft will reach its objective of 4,000 ft. during the present year. On the new levels a number of sections of high-grade mineralization have been opened up with a large tonnage of $30 ore indicated. Bullion production for the year 1931 is

reported at $2,912,308, the cost amounting to $1,696,172, leaving $1,216,136 as profits. During the year the company treated 266,430 tons of ore, with a recovery of $10·67 per ton. The total surplus, including the amount brought forward, was $2,778,442. The ore reserves showed a gain of 134,000 tons. The Teck-Hughes, in an interim financial statement for the quarter ending November 30, 1931, reports a gross income of $1,185,460 as against $1,334,110 for the corresponding period of 1930. Net earnings were $907,160, and estimated surplus, after deductions for depreciation, etc., was $755,150. The new levels are said to be opening up in a satisfactory manner, but it will be some months before their value can be definitely ascertained. At the Kirkland Lake gold mine, the 4,750-ft. level, the lowest level in any Canadian gold mine, is opening up well, with a total of 300 ft. of ore in four places, and values running from $12 to $13. The Sylvanite is nearing the 3,000-ft. objective in its shaft-sinking campaign. When this is completed eight levels will be opened up between the 2,000- and 3,000-ft. horizons. Good ore values recently encountered indicate that the grade will improve at depth. Production is being maintained at the rate of between $70,000 and $80,000 per month and the output of ore is keeping pace with mill requirements. The Barry-Hollinger is meeting with good results at the lower workings. At the 1,700-ft. level 175 ft. of ore, averaging $15 per ton in gold, has been opened up and on the 2,000-ft. level two promising ore shoots have been encountered. The shaft of the Moffatt-Hall is down to 400 ft., its objective being 600 ft. A station will be cut and a level run at 450 ft. At the Macassa the shaft is now down 1,350 ft., its objective being 2,500 ft. and some high-grade ore sections are stated to have been encountered. The drive from the Kirkland Lake property adjoining has been carried for 1,350 ft. and is stated to have passed through 200 ft. of mineralization.

Sudbury.—International Nickel has passed its quarterly dividend on the common stock. A statement was issued by the directors to the effect that whether or not common dividends can prudently be paid for the year now current will depend upon developments which cannot at present be foreseen. Later in the year the question will be re-examined. Exports of nickel by the company during 1931 amounted to 59,041,800 lb. valued at $13,293,414, as compared with 88,850,400 lb. valued at $19,902,920 for 1930. The Falconbridge nickel is finding a steady market for its product and the indications are that sales for the current year may not only cover the current output, but may also include the disposal of a substantial part of the refined nickel stored during 1931. It is understood that there will be no increase in the present capacity until the demand for base metals shows a substantial improvement.

Rouyn.—The Noranda is actively pushing development at depth, including a diamond-drilling campaign, which has greatly increased its ore reserves. On the 2,500 ft. level the company is stated to have proved a width of 400 ft. on the H ore-body. Much of the ore showed values of from 6 to 14% copper, and from $7 to $12 per ton in gold. Work on the 2,000-ft. level shows a width of 250 ft.

Patricia District.—The Howey Gold Mines made great progress during 1931 and in December held the 7th place among the gold producing mines of Ontario. Its output for the year was valued at $865,000, as compared with $460,000 for the first nine months of the preceding year. Substantial improvements were reported in the final quarter. Output for the first half of the year averaged $65,000 per month. In the third quarter $75,000, and in the last three months $84,000 per month. The mill is at present treating about 800 tons of ore daily.

PERSONAL

Adolphus Beckerleg is home from Panama.

G. W. Campion has returned from West Africa.

J. T. Chapple is returning to Malaya.

Donald Gill is home from South Africa.

J. G. Goosman is leaving Bolivia for New Zealand.

H. W. Hardinge has been on a short visit to London.

W. W. Brooke Howard has left for New Caledonia.

Henry Louis has been awarded the Bessemer Medal of the Iron and Steel Institute.

P. H. McDouall is home from Bolivia.

D. B. Mackenzie has returned to Nigeria.

Carl M. Matton has been appointed managing director of the Swedish Diamond Rock Drilling Company.

Deane P. Mitchell has returned from the United States.

J. P. Norrie is home from Northern Rhodesia.

Frank Oates is returning from Tanganyika.

Frank Powell is home from West Africa.

C. H. Russell is returning from Korea.

J. G. Wallworth is returning from British Guiana.

Ernest Williams is here from Western Australia.

David Anderson, for many years secretary of the Burma Corporation, died on February 13, at St. Thomas's Nursing Home, after an operation.

TRADE PARAGRAPHS

Denver Equipment Co., of Denver, Colorado, have issued literature drawing attention to their various laboratory specialities, such as ball and rod mills, classifiers, concentrating tables, jigs and conditioners, and flotation machines.

Demag, A.G., of Duisburg, Germany, in the January issue of their *Demag News* have an interesting article describing tests on air motors of their manufacture such as are used for operating conveyors and hoists. These air motors are made in reversible and non-reversible types and in sizes up to 120 h.p. Another article describes a mine-car locking device on pit cages, and another gives particulars of Demag scraper conveyors in certain classes of colliery production.

Blackstone and Co., Ltd., of Stamford, Lincs., have recently published a new catalogue of their heavy oil, cold starting, engines, to which reference has been made from time to time in these columns. The booklet, which covers some 70 quarto pages, is fully descriptive of the various engine parts and gives all details of size, weights, and suchlike matter. Details are also included of tests carried out under a variety of different conditions. References are also included to other Blackstone products, notably light engines and unchokeable pumps.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders:—For England: Two 4 ft. by 7 ft., type 60, Hummer screens for coal, two 4 ft. by 7 ft., type 39, Hummer screens for coal, two 3 ft. by 5 ft., type 31, 2-surface Hummer screens for soda (repeat order), one No. 3 Clyde hydrator for lime, one No. 00 Raymond pulverizer for dye compounds, one No. 0 Raymond pulverizer for lime, one No. 0000 Raymond pulverizer for colours, one R.L.3 Lopulco mill for calcined magnesite, and one 3 ft. Andrews de-slimer for slurry. They also issue details of a new pump they have developed in association with **Kinetic Elutriators, Ltd.,** for handling abrasive materials, such as thick pulps, classifier feeds, thickener underflows, gravel, sand, and sludge. It is known as the Grit Pump and is lined with a special mechanical rubber, the product of the British Goodrich Rubber Co., Ltd. A cross-sectional elevation is given in Fig. 1, in which the shaded part indicates the lining refered to, and in Fig. 2 is a view of the pump with wearing parts removed. A particular feature is that wear of the gland is prevented by special vanes at the back of the impeller. These cause an outward centrifugal force which keeps back any particles of grit that may tend to get behind the impeller.

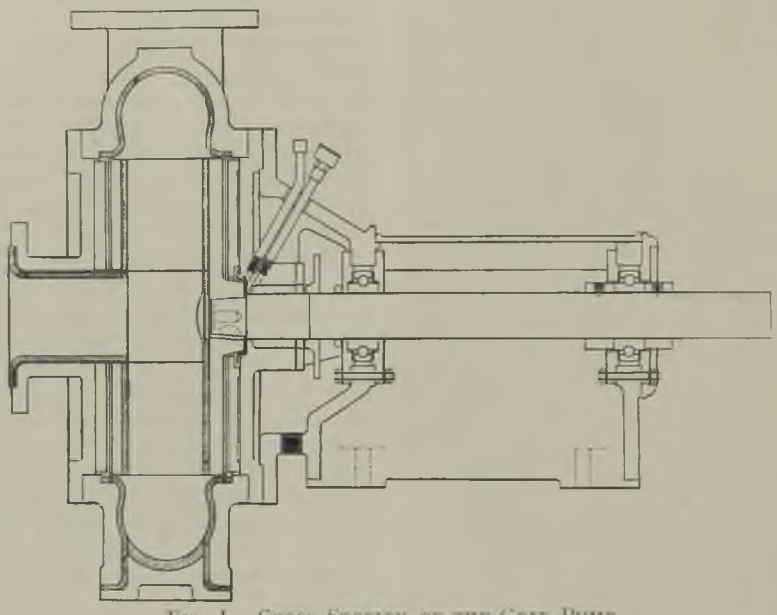


FIG. 1.—CROSS SECTION OF THE GRIT PUMP.

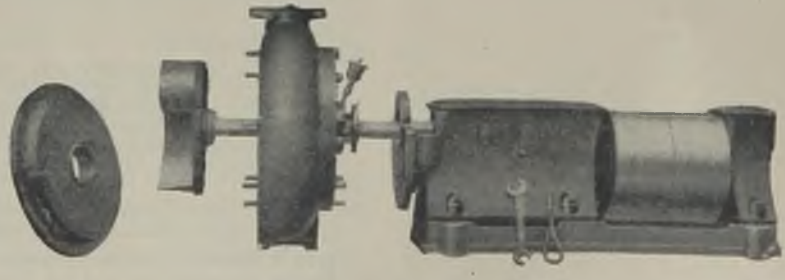


FIG. 2.—PARTS OF THE GRIT PUMP.

Hadfields, Ltd., of East Hecla and Hecla Works, Sheffield, publish a booklet describing their revolving screens of special steel construction. These screens, or trommels, are made in a variety of sizes and meshes for different duties and can be had in " Era " manganese steel if desired.

Westinghouse Electric International Co., of 2, Norfolk Street, London, W.C. 2 (Head Office : New York), state, with reference to the description of the new hoist supplied to Lake Shore Mines given in the Mining Digest in the MAGAZINE for January, that the mechanical equipment for this hoist was supplied by the Canadian Ingersoll-Rand Company, of Sherbrooke, Quebec. They also report that their Canadian Company has recently obtained an additional hoist contract with Noranda Mines in which the mechanical hoist equipment has been supplied by the Nordberg Company and manufactured in Canada.

BRITISH INDUSTRIES FAIR

The British Industries Fair was held as usual at London and Birmingham from February 22 to March 4. The Birmingham section was of more particular interest to engineers and below brief notes are given about some of the principal exhibits likely to appeal to mining men. A special feature of the fair this year was an outdoor exhibit entitled " From Quarry to Road," which afforded an opportunity of demonstrating the employment of such equipment as excavators, rock breakers, pneumatic drills and road tools, and a variety of light railway transport.

Cassel Cyanide Co., Ltd., of Imperial Chemical House, London, S.W. 1, were demonstrating the use of sodium cyanide for case-hardening purposes.

Crompton Parkinson, Ltd., of Bush House, London, W.C. 2, were showing a.c. and d.c. motors, fractional motors, transformers, and switchgear.

W. C. Holmes and Co., Ltd., of Huddersfield, were demonstrating by means of models and drawings the Holmes-Connersville blowers and exhausters.

W. H. Allen, Sons, and Co., Ltd., of Bedford, were showing a six cylinder, vertical airless injection Diesel engine of 200 b.h.p. and examples of their centrifugal pumps.

Stanton Ironworks Co., Ltd., near Nottingham, were showing their spun iron pipes in various lengths suitable for hydraulic or oil pipeline service, together with flexible pipe joints.

Dermatine Co., Ltd., of 93 to 95, Neate Street, London, S.E. 5, were exhibiting belting for driving and conveying purposes, as well as hose suitable for air drills and various suction and delivery purposes.

N. Greening and Sons, Ltd., of Warrington, were showing woven wire of all meshes and gauges and perforated metals of all sizes, as well as wedge wire screens, rotary screens, and wire conveyor belts.

British Timken, Ltd., of Aston, Birmingham, among the various examples of Timken tapered roller bearings, illustrated their use in conveyor idlers and in the running centre of a mine car wheel.

Quasi-Arc Co., Ltd., of 15, Grosvenor Gardens, London, S.W. 1, were showing their special arc-welding plant and electrodes, as well as examples of its application, and were giving demonstrations of welding.

Macinlop, Ltd., of Manchester, were displaying rubber belting for transmission and conveyor purposes, together with hose piping for suction and delivery, as well as anti-corrosion rubber linings.

R. and J. Dick, Ltd., of Glasgow, were showing their well-known belting for power transmission, conveying, and elevating purposes ; also a form of driving rope as another means of power transmission.

G. D. Peters and Co., Ltd., of Slough, Bucks, were exhibiting examples of their plastic-arc electric welding plants and " Colour-Tipt " electrodes and some special welding metals for high-speed and high-grade welds.

Redler Patents, of Sharpness, Glos., were demonstrating their special system for conveyance of granular matter such as ores, coal, etc., including both conveyors and elevators, the latter being a bucketless type.

Goodwin, Barsby, and Co., Ltd., of Leicester, were showing crushers, granulators, screens, elevators, and conveyors. Crushers and granulators are of the Blake jaw type and the screens of the rotating trommel.

Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, were demonstrating by means of a series of diorama the various applications of nickel and its alloys in the engineering, chemical, and other industries.

E. F. Sargeant, of Skelton, York, was showing working models of cableway excavators, scraper excavators, and scraper pumps for gravel pits and excavating generally, also means for storage and handling of materials.

J. H. Holmes and Co., Ltd., of Hebburn-on-Tyne, had a representative display of their electrical products including d.c. motors, a.c. motors, a special a.c. coal conveyor motor, as well as electric welding equipment and distribution gear.

Stewarts and Lloyds, Ltd., of Glasgow, were showing weldless steel, lapwelded, wrought-iron and steel tubes and fittings, including Victaulic pipe joints, and also steel pit props and poles and a variety of iron and steel castings, plates, etc.

British Oxygen Co., Ltd., of Angel Road, Edmonton, London, N. 18, were displaying oxy-acetylene and electric welding equipment and accessories and, in connexion with the outdoor exhibit referred to above, acetylene flares and hand lamps.

Murex Welding Processes, Ltd., of Walthamstow, E. 17, were exhibiting examples of their arc-welding plant, welding transformers, atomic hydrogen and automatic welding plant, and various types of electrodes for different steels and other metals.

Thomas Locker and Co., Ltd., of Warrington, were exhibiting woven wire cloth and perforated metals and, in addition, examples of the " Supreme " electrically-operated vibrating screens and conveyors such as were described in the MAGAZINE for April and July, 1930.

Canadian Government.—The Canadian Government exhibit, as in the past, represented a number of Canadian industries and railways and also included a section drawing attention to the mineral wealth of the Dominion exemplified by statistics and mineral specimens.

Alfred Herbert, Ltd., of Coventry, were demonstrating the Atritor unit coal pulverizing system and its application to the firing of a forging furnace. A No. 6 Atritor was also shown open for

inspection of the feeding, separating, drying, pulverizing, and discharging parts.

United Steel Companies, Ltd., of 17, Westbourne Road, Sheffield, were showing a variety of steel castings and forgings and the products of various of their component companies, together with special steels and special steel products, such as wires, tools, and special alloy steels.

George Ellison, Ltd., of Perry Bar, Birmingham, were displaying switchgear for control of power in every industry, including an 11,000 volt sub-station, metal-clad and overhead line switches, switchboards, circuit breakers, motor starters and controllers, and flame-proof mining control gear.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E 7, manufacturers of perforated metal and woven wire in all gauges and a variety of sheet metal and plate work, were occupying a stand containing a representative exhibit of their products, as on former occasions.

H. R. Marsden, Ltd., of Soho Foundry, Leeds, at the out-door exhibit had a complete Blake Marsden crushing plant in operation, consisting of 20 in. by 12 in. crusher, elevator, screening and storage plant. This was being employed to break down large pieces of stone, which was to be subsequently used for laying a road in the vicinity.

Thos. Firth and John Brown, Ltd., of Sheffield, occupied a large stand principally devoted to demonstrating Staybrite steel and special alloy steels and tool steels, but in addition they were showing on part of the stand various steels, and the parts made from them, which they make for the mining industry, notably dredger and crusher parts.

Babcock and Wilcox, Ltd., of Farringdon Street, London, E.C. 4, in addition to examples of their boiler installations and accessories, such as Bailey water-cooled furnace walls, oil-firing equipment, etc., were showing single-cylinder oil engines, notably one horizontal of 85 b.h.p. of the compression ignition type and another smaller engine of the hot-bulb type.

Broom and Wade, Ltd., of High Wycombe, Bucks, were represented on a stand and also in the outdoor exhibit. Their indoor exhibit included an air-compressor driven by a patent sleeve valve petrol engine having a capacity of 100 cu. ft. of free air per minute and one of their compressors was working outside delivering air to drills and paving breakers.

Hudswell, Clarke, and Co., Ltd., of Leeds, who occupied a stand and were also represented in the outdoor exhibit, were making a feature of Diesel engine rail transport equipped with the Vickers-Coats converters, by means of which the usual gearbox is dispensed with. They had examples of both a 20 h.p. and a 26 h.p. engine. The firm are also makers of electric-battery locomotives for underground transport.

John Bedford and Sons, Ltd., of Sheffield, who had a stand devoted to a variety of steel tool products, such as files, shovels, and hammers, were making a feature of their special copper-core hollow drill steel which is already well known to mining engineers. A more recent development in the direction of a perfectly cored drill steel, of which an example was shown, is the use of stainless steel core. Stocks of Bedford drill steel are held by a number of agents in all parts of the world.

Fraser and Chalmers Engineering Works, of Erith, Kent, were demonstrating Robins portable belt conveyors and two other types of more particular interest to factory operators. They were also showing vibrating screens, as described in the MAGAZINE for April, 1930, and April, 1931, and coal washing and drying equipment. On this occasion they occupied a stand separate from that on which the **General Electric Company,** the proprietors, were showing electric lighting and suchlike products.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, had a representative exhibit of their various products, including a working model of the Raymond roller mill with air separation, a full-size double vibrator Hum-mer screen (which it is interesting to add is now completely manufactured in this country at their works at Derby), the Rovac filter, a new type of grit pump, shown in conjunction with **Kinetic Elutriators, Ltd.,** which is described elsewhere in this issue, together with the laboratory elutriator and the de-slimer which are already well-known as products of the latter firm.

Robert Hudson, Ltd., of Leeds, were the occupants of a large stand on which they were showing various types of tipping wagons for mine service and light railway accessories. In addition they were showing, in conjunction with the **Hunslet Engine Co., Ltd.,** of Leeds, a 35 h.p. Diesel locomotive in which a Ruston 2-cylinder vertical oil engine was fitted. They were also represented in the outdoor exhibit, where a large 300 cu. ft. capacity automatic double side-tipping wagon was shown being hauled by a 150 h.p. Hunslet Diesel locomotive, which in this case was equipped with a M.A.N. engine.

Ruston-Bucyrus, Ltd., of Lincoln, occupied a stand, but their most interesting exhibit was that included in the outdoor display. Here they were showing in operation the new model 21-B ¾ cu. yd. Diesel dragline on caterpillar mounts and also another machine of the same type, but adapted as a back trencher. These machines are equipped with the 4-cylinder Ruston Diesel engine of 64 h.p., which is specially designed and produced for this purpose by **Ruston and Hornsby, Ltd.** On the inside stand a complete caterpillar frame of the improved No. 4 ½ yd. machine and a 6-cylinder Diesel engine, as fitted to the 1 yd. excavator, were shown.

Holman Bros., Ltd., of Camborne, Cornwall, occupied a large stand on which were exhibited examples of most of their products of interest to mining men. These included rock drills and air-compressors, both stationary and portable, and the Hele-Shaw-Beecham air motor, which latter was exemplified as a prime mover for a number of small hoists. In connexion with this they had an exhibit of special interest of their scraper-haulage system operated by double-drum hoists driven by an air motor. In addition they were represented in the outdoor exhibit, where they were showing a special type of core-drill, which they have manufactured to the requirements of the Ministry of Transport for taking samples of road sub-surface to determine whether the concrete is made and laid according to specification.

Imperial Chemical Industries, Ltd., of Imperial Chemical House, Millbank, London, S.W.1., were represented at both the London and Birmingham sections of the fair. In the former, on a stand devoted to various of their chemical products, was a section illustrating the explosives branch of their industry, and in the latter, in addition to the exhibit referred to under the heading of the Cassel Cyanide Co.,

they were represented on a large stand devoted to the non-ferrous metals and alloys, such as plates, strips, sheets, tubes, sections, etc., these being the products of I.C.I. Metals. They were further represented on a stand devoted to demonstrating the use of an ammonia cracker for supplying a ready source of hydrogen for industrial operations, such as metal cutting and welding. Another stand was given over to demonstrating means for the rapid removal of oil and grease from metal parts, such as have been described in these columns before.

METAL MARKETS

The following reports on the metal and ore markets cover the month of February, and the prices quoted therein are those ruling on February 29. With the 10% tariff coming into force on March 1 some of these prices will probably be adjusted to meet the altered conditions, but those relating to copper, tin, lead, and spelter remain on a duty-free basis in accordance with a decision of the London Metal Exchange, dated February 12.

COPPER.—February was a very disappointing month for copper producers, the quotation for electrolytic falling from 6·87½ cents per lb. c.i.f. Europe, on January 29 to 5·87½ cents on February 11, subsequently recovering to 6·37½ cents, but closing the month at 6·12½ cents. The standard market in London, after showing some weakness, rallied on anticipations of the effect of the proposed import duty to take effect on March 1. Fresh weakness, however, appeared when it was known that copper was on the free list. Industrial demand for copper has remained dull everywhere. Producers were busy in New York at the end of the month discussing future policy and so discouraging was the general situation that the possibility of Copper Exporters being broken up was freely discussed. Huge stocks are being carried and some American interests are strongly in favour of a general shut-down.

Average price of Cash Standard Copper: February, 1932, £36 19s. 8d.; January, 1932, £39 10s. 1d.; February, 1931, £45 8s. 3d.; January, 1931, £44 19s. 7d.

TIN.—The tin market was fairly steady during February. There has been no fresh development, American demand remaining dull, whilst, thanks to their output-curtailment system, producers seem to have checked the expanding tendency of stocks to some extent. Although the position is under considerable control, some consumers regard the market with suspicion, particularly as the Tin Pool, which had previously reported its holding as 21,000 tons of tin, failed to make any fresh statement regarding these at its meeting in the latter part of February.

Average price of Cash Standard Tin: February, 1932, £139 4s. 7d.; January, 1932, £140 5s. 6d.; February, 1931, £118; January, 1931, £115 17s. 7d.

LEAD.—This was a somewhat sluggish market until tariff developments stimulated interest, but the resulting advance in prices was not fully maintained, partly because of weak advices from the United States, where the quotation was reduced towards the end of the month from 3·75 cents to 3·50 cents per lb. New York. World stocks have continued to increase and are now believed to be substantially higher than 300,000 tons. Obviously the rate of curtailment at the smelters is inadequate. The exaction of premiums by sellers of non-dutiable Empire lead has aroused dissatisfaction amongst British consumers and the Government has authorized an investigation of the matter by the Tariff Advisory Committee. It is not impossible that eventually both lead and spelter may also be included on the free list.

Average mean price of soft foreign lead: February, 1932, £14 11s. 3d.; January, 1932, £15 2s. 1d.; February, 1931, £13 9s. 11d.; January, 1931, £13 17s. 9d.

SPELTER.—This market had a variable aspect during February. Prices were stimulated in the middle of an easier trend by the imminence of the British tariff, but the firmer tone was not long maintained. With demand from consuming trades restricted and with the stocks held by the Cartel believed to be increasing, despite the very drastic rate of output-curtailment, the outlook for the metal is certainly not particularly encouraging.

Average mean price of spelter: February, 1932, £14 1s. 7d.; January, 1932, £14 12s. 6d.; February, 1931, £12 9s. 11d.; January, 1931, £12 18s. 7d.

IRON AND STEEL.—Mediocre conditions prevailed on the British pig-iron market during February. Indian pig continues to be a thorn in the side of home makers and of course the new British tariff will not affect imports from that quarter. Cleveland prices are unaltered with No. 3 g.m.b. quoted at 58s. 6d. minimum. Some hematite furnaces have been damped down on the West Coast, but despite this restriction of output the market is over-supplied and, although makers are endeavouring to maintain 64s. as the value of East Coast Mixed Numbers, less is accepted. The British steel industry remains in an unsatisfactory condition and the 10% import duty is not expected to improve matters very much in view of the extremely low level of Continental prices.

IRON ORE.—Business has not attained very large proportions in February, ironmasters having having plenty of material on contract. On the Continent the situation is very serious, users being months in arrears with their deliveries. Best Bilbao rubio remains at 16s. 6d. c.i.f.

ANTIMONY.—At the close of the month English regulus was priced at about £40 to £42 10s. per ton. Business in foreign regulus was dull, with prices somewhat erratic owing to the Chinese situation and the British import tariff. For shipment, Chinese material was offered at about £25 12s. 6d. c.i.f., but spot sold around £32, ex-warehouse.

ARSENIC.—Business increased immediately prior to the tariff becoming operative, importers being anxious to secure additional supplies. Cornish remains scarce and nominal at about £23 10s. to £24 f.o.r. mines, whilst Mexican is quoted only against definite enquiries.

BISMUTH.—The official price is without change at 4s. 10d. per lb. for merchant quantities, business being moderate.

CADMIUM.—Since most of the supplies for our market come from Empire sources buyers have not been stampeded by the tariff and a quietly steady business has been passing at 2s. 4d. to 2s. 5d. per lb.

COBALT METAL.—With plentiful supplies in Canada the 10% duty on this metal is not likely to make much difference. The official price is unaltered at 3·65 dollars per kilo.

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.		GO
	Standard.		Electro-lytic.	Best Selected.			Soft Foreign.	English.			
	Cash.	3 Months.							Cash.	For-ward.	
Feb.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	
11	35 6 10½	35 4 4½	39 15 0	—	136 3 9	139 0 0	13 11 3	14 13 9	16 0 0	19½	120
12	36 17 6	36 11 10½	41 5 0	40 0 0	138 5 0	141 0 0	14 0 0	14 16 3	16 5 0	19⅝	120
15	38 11 3	38 6 3	41 5 0	—	140 13 9	143 11 3	14 6 3	15 0 0	16 10 0	19⅝	119
16	37 18 9	37 6 10½	42 10 0	40 10 0	139 11 3	142 6 3	14 7 6	14 18 9	16 10 0	19⅝	120
17	38 16 3	37 18 9	42 10 0	—	140 12 6	143 8 9	14 8 9	15 0 0	17 0 0	19⅞	120
18	38 18 9	38 6 3	42 0 0	—	140 16 3	143 8 9	14 7 6	15 0 0	17 0 0	19⅞	120
19	38 12 6	37 19 4½	41 10 0	40 10 0	140 5 0	142 16 3	14 5 0	14 18 9	16 15 0	19⅝	120
22	38 8 9	37 8 9	41 5 0	—	140 13 9	143 3 9	14 2 6	14 15 0	16 15 0	19⅝	120
23	37 0 0	36 8 9	41 5 0	40 0 0	139 16 3	142 5 0	13 15 0	14 7 6	16 5 0	19⅝	119
24	35 15 0	35 16 10½	41 0 0	—	139 6 3	141 11 3	13 5 0	14 2 6	15 15 0	19⅝	118
25	35 6 3	35 8 9	39 15 0	—	139 1 3	141 8 9	13 5 0	14 5 0	16 0 0	19⅝	118
26	33 8 1½	33 11 3	38 15 0	36 10 0	137 17 6	140 5 0	13 7 6	13 17 6	15 10 0	19⅝	118
29	33 15 7½	34 3 9	38 10 0	—	138 11 3	140 17 6	13 0 0	13 10 0	15 0 0	19⅜	118
Mar.											
1	32 6 10½	32 16 3	37 0 0	35 0 0	137 16 3	140 1 3	13 1 3	12 8 9	14 5 0	19⅜	118
2	33 3 9	33 13 9	37 10 0	—	138 17 6	141 2 6	13 7 6	12 11 3	14 15 0	19⅜	118
3	34 1 3	34 10 7½	38 5 0	—	139 13 9	141 13 9	13 11 3	12 16 3	14 15 0	19⅜	118
4	34 8 1½	34 16 10½	39 5 0	37 5 0	139 16 3	141 15 0	13 10 0	13 0 0	15 0 0	19¼	118
7	34 16 3	35 3 9	40 10 0	—	137 12 6	139 3 9	13 5 0	13 0 0	15 0 0	19⅛	117
8	33 18 9	34 8 9	39 10 0	37 0 0	133 2 6	134 12 6	12 18 9	12 17 6	15 0 0	18⅞	115
9	32 18 9	33 5 7½	37 10 0	—	130 0 0	131 12 6	12 15 0	12 12 6	14 15 0	17⅞	110
10	33 3 9	33 11 3	36 15 0	—	130 10 0	132 2 6	12 16 3	12 13 9	14 15 0	17⅞	112

Cobalt Oxides.—Some moderate sales have been effected, but prices are without change at about 5s. 3d. to 5s. 4d. per lb. for black and 6s. to 6s. 1d. for grey.

Chromium Metal.—Demand expanded owing to pre-tariff purchases, but the price remains at about 3s. per lb.

Tantalum.—A fair business has been passing at around £25 to £30 per lb.

Platinum.—The trade here was relieved when it was learned that platinum had been placed upon the free list. Demand has been fair, but owing to exchange movements the price has been lowered to £10 15s. to £11 1s. per oz. for refined metal.

Palladium.—Quotations are nominally about £5 5s. to £5 10s. per oz.

Iridium.—Demand has been slow but prices declined in sympathy with platinum, sponge and powder now standing at about £20 to £21 per oz.

Osmium.—Quotations are rather easier at about £18 to £19 per oz.

Tellurium.—There is nothing doing and prices are quite nominal.

Selenium.—A steady demand has been maintained at about 7s. 8d. to 7s. 9d. (gold) per lb.

Manganese Ore.—The absence of any improvement in the steel trade precludes any expansion in the demand for manganese ore, and business has been to all intents and purposes at a standstill. Quotations, however, are nominally unchanged at 10½d. to 10½d. per unit c.i.f. for best Indian ore, and 9d. to 9½d. c.i.f. for good 48% Indian and washed Caucasian.

Aluminium.—The most interesting development in February was the purchase of a controlling interest in the Aluminium Corporation Ltd., of Dolgarrog, by the Alliance Aluminium Compagnie A.-G. of Basle, the controlling concern of the Aluminium Cartel. Demand here was stimulated somewhat owing to the imminence of the tariff, but the general level of activity is unsatisfactory. Quotations here remain at £95, less 2% delivered, for ingots and bars.

Sulphate of Copper.—English makers quoting about £19 to £19 10s. per ton less 5%

Nickel.—Since about 90% of the world's nic output comes from Canada, the tariff is not lik to affect supplies for our market, and prices without change at £240 to £245 per ton, accord to quantity.

Chrome Ore.—With plentiful supplies availa from within the Empire, the tariff will not aff the market much. Meanwhile a quiet busin continues at unchanged prices, good 48% Rhodes ore being about 80s. to 85s. per ton c.i.f. and N Caledonian 100s. to 110s. c.i.f.

Quicksilver.—Material to arrive was quoted the end of February at about £17 15s. per bott net, c.i.f., but spot material was held for £19 a upwards, sellers being reserved owing to t prospects of higher prices after the tariff beca operative.

Tungsten Ore.—Consumption has fallen but a fraction of the normal volume, and buy are doing little or nothing. Sellers are offer Chinese ore for shipment at about 14s. 9d. to 1 per unit c.i.f., buvers' ideas having receded to abo 14s. 3d.

Molybdenum Ore.—Supplies became rath scarce during February from sources outside t combine, and with a fairly good demand pri stiffened to about 38s. to 40s. per unit c.i.f.

Graphite.—Business remains slow with pri unchanged at about £16 to £18 c.i.f. for 85 to 90 raw Madagascar flake, and £17 to £19 c.i.f. for 90 Ceylon lumps.

Silver.—Price movements in the silver mark during February were on a fairly small scale a business, generally speaking, was slight. Sell were rather reserved owing to the Chinese situati and the moderate American offerings were fa well absorbed by the Continent and China, alt a period of easiness in the first few days of the mont On February 1 spot bars were quoted at 20d p oz., but quickly fell away to 19⅛d., recovering 19⅝d. on February 15, and closing at 19½d February 29

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
February, 1931	800,991	38,946	839,937
March	869,331	41,667	910,998
April	840,259	42,078	882,337
May	867,949	42,330	910,279
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784
February	869,711	44,301	914,012

TRANSVAAL GOLD OUTPUTS.

	January.		February.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	98,000	£153,941	96,500	£151,833
City Deep	79,000	20,999	77,500	20,473
Cons. Main Reef	70,800	23,954	68,500	23,019
Crown Mines	274,000	83,287	260,000	80,100
Daggafontein	21,000	£13,556	31,000	£40,673
D'rb'n Roodepoort Deep	49,700	15,813	47,000	15,448
East Geduld	52,000	15,476	51,000	15,436
East Rand P.M.	161,000	42,294	152,000	40,325
Geduld	85,500	27,150	81,000	25,932
Geldenhuis Deep	74,500	16,993	71,000	17,002
Glynn's Lydenburg	6,600	2,572	6,100	2,345
Government G.M. Areas	204,000	£403,290	200,000	£389,510
Kleinfontein	53,400	10,314	49,000	9,666
Langlaagte Estate	80,000	£111,664	77,000	£107,180
Luipaard's Vlei	33,200	8,351	31,100	7,823
Meyer and Charlton	18,400	£17,284	17,200	£16,622
Modderfontein New	169,000	65,923	161,000	63,080
Modderfontein B	76,500	21,584	72,500	20,495
Modderfontein Deep	44,800	22,091	43,000	20,922
Modderfontein East	73,500	21,502	72,000	21,101
New State Areas	80,000	£170,683	82,000	£172,064
Nourse	71,000	21,006	68,000	20,209
Randfontein	248,000	£280,569	232,000	£267,286
Robinson Deep	98,300	£119,481	92,800	27,062
Rose Deep	61,400	12,898	59,600	12,785
Simmer and Jack	82,100	£92,717	78,500	21,348
Springs	68,500	£149,845	67,500	£148,264
Sub Nigel	36,700	£133,722	35,000	30,698
Transvaal G.M. Estates	16,600	5,187	17,100	4,918
Van Ryn	47,500	£44,679	45,500	£42,748
Van Ryn Deep	65,000	£94,162	66,000	£93,300
West Rand Consolidated	94,500	£105,725	89,000	£100,718
West Springs	75,000	£75,935	73,800	£75,570
Vitw'tersr'nd (Knights)	67,000	£56,465	62,000	£51,473
Witwatersrand Deep	44,000	13,183	42,200	12,947

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

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

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
ov., 1930	2,628,800	28 4	19 7	8 9	1,145,097
ecember	2,661,200	28 6	19 9	8 9	1,160,548
nuary, 1931	2,721,316	28 3	19 8	8 7	1,171,456
bruary	2,481,600	28 6	20 1	8 5	1,045,980
arch	2,718,400	28 2	19 9	8 5	1,151,017
ril	2,592,800	28 7	20 1	8 6	1,105,711
y	2,751,400	27 10	19 6	8 4	1,149,105
ne	2,698,100	28 0	19 7	8 5	1,140,399
ly	2,771,400	27 10	19 6	8 4	1,155,466
gust	2,799,800	27 10	19 5	8 5	1,159,382
ptember	2,765,400	27 10	19 5	8 5	1,162,355
tober	2,870,800	27 8	19 3	8 5	1,210,743
vember	2,726,720	27 10	19 5	8 5	1,144,208
cember	2,793,900	27 10	19 5	8 5	1,173,732
nuary, 1932	—	—	—	—	1,163 434

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
February 28, 1931	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781
April 30	206,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744
February 29	216,171	12,177	1,363	229,711

PRODUCTION OF GOLD IN RHODESIA.

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

RHODESIAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	9,932	23,400	9,437
Globe and Phœnix	6,060	6,047	6,094	6,286
Lonely Reef	7,700	2,402	7,500	2,435
Luiri Gold	1,330	932	—	—
Rezende	6,500	2,608	6,100	2,428
Sherwood Star	4,800	£9,168	4,600	£8,705
Wanderer Consolidated	15,200	3,589	14,300	3,519

WEST AFRICAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,745	£10,455	—	—
Ashanti Goldfields	13,063	14,596	12,918	14,262
Taquah and Abosso	10,547	£14,403	9,640	£13,137

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
February, 1931	38,370	4,458*	458
March	34,946	4,482	898
April	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	3,641	1,220
August	52,501	3,020	610
September	38,173	—	638
October	52,741	7,838†	1,031
November	53,869	4,758	1,428
December	49,215	—	1,224
January, 1932	44,037	—	—
February	44,672	—	—

* Jan. and Feb. † Sept. and Oct.

AUSTRALASIAN GOLD OUTPUTS.

	January.		February.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,067	5,297	4,921	5,105
Blackwater (N.Z.)	2,000	6,132	3,601	7,821
Boulder Persev'ce (W.A.)	7,237	15,006	7,074	14,845
Grt. Boulder Pro. (W.A.)	8,920	20,479	9,337	23,722
Lake View & Star (W.A.)	18,945	32,646	—	—
Sons of Gwalia (W.A.)	13,048	15,260	13,242	15,637
South Kalgurli (W.A.)	9,643	15,145	8,898	15,238
Waihi (N.Z.)	23,108	6,815* / 46,015†	—	—
Wiluna	27,020	34,015	26,233	33,635

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	January.		February.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,250	1,700	3,000	2,101
Champion Reef	8,650	5,406	8,680	5,227
Mysore	17,074	7,155	15,379	6,609
Nundydroog	12,350	7,205	12,060	7,104
Ooregum	11,150	4,369	11,175	4,364

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	January.		February.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	10,320	18,800	9,230	15,920
Frontino Gold (C'lbia)	3,260	19,419	3,430	17,133
Fresnillo	84,195	15,353*d*†	—	—
New Goldfields of Venezuela	6,596	1,693*	6,485	1,815*
Oriental Cons. (Korea)	16,911	87,808*d*	8,214	70,067*d*
Remance	4,004	4,300	—	—
St. John del Rey (Brazil)	—	34,500	—	35,200
Santa Gertrudis (Mexico)	25,463	32,261*d*	—	—
Viborita	—	1,780‡	—	696
West Mexican Mines	1,470	27,000*d*	—	—

d Dollars. * Oz. gold. † Loss. ‡ To Jan. 16

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1931	4,757	January, 1932	3,014
August	5,375	February	2,152
September	2,449	March	—
October	3,282	April	—
November	2,488	May	—
December	3,222	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	December.	January.	February.
Ayer Hitam	113	29¾	—
Batu Caves	40	—	—
Changkat	45	90	75
Gopeng	60	32	7
Hongkong Tin	77½	48¾	—
Idris Hydraulic	41½	6¾	—
Ipoh	28½	36	24¾
Kampar Malaya	—	—	—
Kampong Lanjut	50	50	35
Kamunting	99	70	96
Kent (F.M.S.)	34	15	—
Kinta	22½	20	—
Kinta Kellas	23¾	26¾	—
Kramat Tin	70	85	85
Kuala Kampar	28	40	38
Kundang	—	—	—
Lahat	13½	14½	7¾
Lower Perak	119	85	—
Malaya Consolidated	—	—	—
Malayan Tin	77½	89½	90½
Malim Nawar	22	25	21
Pahang	125	125	125
Penawat	—	—	—
Pengkalen	75	14	—
Petaling	68	155	90
Rahman	40	40⅝	40⅝
Rambutan	12	4½	—
Rantau	25	11¾	17½
Rawang	40	30	52
Rawang Concessions	35	37	35
Renong	25¼	22½	28
Selayang	—	17⅝	—
Southern Malayan	137	113	3½
Southern Perak	26⅜	53½	11½
Southern Tronoh	31	24	16
Sungei Besi	33	33	33
Sungei Kinta	15½	22½	16
Sungei Way	77½	68⅜	—
Taiping	18¾	17	14
Taniong	13¾	12	19
Teja Malaya	—	—	—
Tekka	30	27	—
Tekka Taiping	45	40½	2
Temengor	—	—	—
Temoh	—	—	—
Tronoh	25	52	80
Ulu Klang	18½	—	12½

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	December.	January.	February.
Anglo-Nigerian	69¾	53¾	—
Associated Tin Mines	255	230	129
Baba River	6	4⅞	—
Batura Monguna	3	1½	—
Bisichi	30	37	27
Daffo	5	5	—
Ex-Lands	49	56	34
Filani	6	3	—
Jantar	12	10	18
Jos	11	11⅜	—
Juga Valley	6	5½	8¼
Kaduna Syndicate	30	25	—
Kaduna Prospectors	11	11	—
Kassa	15½	15	—
London Tin	160	150	143
Lower Bisichi	3¾	4	—
Naraguta Extended	—	—	—
Nigerian Consolidated	10½	12	12½
Offin River	2½	3½	3
Ribon Valley	16½	12	4¾
Tin Fields	5½	—	4½
United Tin Areas	25	22½	—
Yarde Kerri	4	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	December.	January.	February.
Anglo-Burma (Burma)	41	28	17½
Aramayo Mines (Bolivia)	127	130	134
Bangrin (Siam)	—	—	—
Beralt	30*	30*	30*
Consolidated Tin Mines (Burma)	95	95	95
East Pool (Cornwall)	49¾	49	—
Fabulosa (Bolivia)	40†	47†	39†
Kagera (Uganda)	25	18	—
Kamra	—	—	—
Malaysiam Tin	8½	8½	8¾
Mawchi	203½*	200*	—
Patino	1,056	907	—
Pattani	—	—	—
San Finx (Spain)	—	20*	—
Siamese Tin (Siam)	46½	25½	25½
South Crofty	51½	49	51½
Tavoy Tin (Burma)	61	55	27
Tongkah Harbour (Siam)	48	40	40
Toyo (Japan)	73	60½	62
Zaaiplaats	16⅞	—	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		Jan.	Feb.
Britannia Lead	Tons refined lead	2,602	—
	Oz. refined silver	64,000	—
Broken Hill South	Tons lead conc.	7,181	4,839
	Tons zinc conc.	7,506	4,914
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	490,000	490,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	350	350
Messina	Tons copper	775	744
Mount Isa	Tons lead bullion	3,704	—
Mount Lyell	Tons concentrates	3,429	3,487
North Broken Hill	Tons lead conc.	4,330	—
	Tons zinc conc.	4,047	—
Rhodesia Broken Hill	Tons V_2O_5	35	35
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	2,457	3,082
San Francisco Mexico	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Tetiuhe	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Trepca	Tons lead conc.	3,915	3,041
	Tons zinc conc.	3,776	3,814
Zinc Corporation	Tons lead conc.	6,314	—
	Tons zinc conc.	4,811	—

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

		December.	January.
Iron Ore	Tons	235,032	156,461
Manganese Ore	Tons	2,928	7,722
Iron and Steel	Tons	266,901	170,435
Copper and Iron Pyrites	Tons	39,546	20,600
Copper Ore, Matte, and Prec.	Tons	3,476	6,105
Copper Metal	Tons	9,904	8,499
Tin Concentrate	Tons	5,236	5,241
Tin Metal	Tons	2,164	900
Lead Pig and Sheet	Tons	32,348	21,363
Zinc (Spelter)	Tons	10,005	10,025
Zinc Sheets, etc.	Tons	2,233	800
Aluminium	Tons	883	643
Mercury	Lb.	172,606	119,173
Zinc Oxide	Tons	314	136
White Lead	Cwt.	10,329	9,430
Red and Orange Lead	Cwt.	5,270	2,973
Barytes, ground	Cwt.	39,313	23,842
Asbestos	Tons	1,842	532
Boron Minerals	Tons	726	1,262
Borax	Cwt.	39,873	20,731
Basic Slag	Tons	6,607	2,700
Superphosphates	Tons	5,914	5,145
Phosphate of Lime	Tons	18,888	37,255
Mica	Tons	151	149
Sulphur	Tons	8,256	8,284
Nitrate of Soda	Cwt.	97,475	62,600
Potash Salts	Cwt.	180,228	97,723
Petroleum: Crude	Gallons	14,562,159	30,835,128
Lamp Oil	Gallons	28,032,400	26,215,960
Motor Spirit	Gallons	72,312,499	68,270,522
Lubricating Oil	Gallons	7,162,500	4,062,498
Gas Oil	Gallons	10,125,648	12,191,905
Fuel Oil	Gallons	32,296,597	38,061,304
Asphalt and Bitumen	Tons	10,613	9,368
Paraffin Wax	Cwt.	152,711	140,999
Turpentine	Cwt.	35,382	14,389

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	December.	January.	February.
Anglo-Ecuadorian	18,014	18,038	14,555
Apex Trinidad	43,380	44,310	43,870
Attock	1,809	1,611	1,782
British Burmah	4,350	4,416	3,949
British Controlled	39,738	39,970	—
Kern Mex	934	984	927
Kern River (Cal.)	2,554	2,436	2,195
Kern Romana	670	564	282
Kern Trinidad	4,792	4,968	3,684
Lobitos	25,746	25,327	21,701
Phœnix	45,707	46,884	44,572
St. Helen's Petroleum	5,053	5,089	4,911
Steaua Romana	87,054	85,711	80,394
Tampico	2,563	2,678	2,579
Tocuyo	1,730	1,784	1,384
Trinidad Leaseholds	13,650	21,300	25,700

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	Feb. 10, 1932.			Mar. 10, 1932.		
	£	s.	d	£	s.	d.
Anglo-Ecuadorian		5	9		6	6
Anglo-Egyptian B.	1	3	9	1	5	6
Anglo-Persian 1st Pref.	1	3	3	1	5	0
,, ,, Ord.	1	16	3	1	17	6
Apex Trinidad (5s.)		10	6		10	6
Attock		11	3		12	6
British Burmah (8s.)		4	0		4	0
British Controlled ($5)		1	6		1	6
Burmah Oil	1	16	9	2	3	9
Kern River Cal. (10s.)		2	0		2	0
Lobitos, Peru	1	2	6	1	4	3
Mexican Eagle, Ord. (4 pesos)		7	0		7	0
,, ,, 8% Pref. (4 pesos)		6	9		7	6
Phœnix, Roumanian		4	0		4	6
Royal Dutch (100 fl.)	15	5	0	17	10	0
Shell Transport, Ord	1	19	3	2	3	0
,, ,, 5% Pref. (£10)	9	0	0	9	15	0
Steaua Romana		4	3		5	6
Trinidad Leaseholds	1	5	0	1	5	6
United British of Trinidad (6s. 8d.)		3	0		2	6
V.O.C. Holding	1	0	9	1	4	6

PRICES OF CHEMICALS. March 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	17	3
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	7	0	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	25	5	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	11	0	0
Barytes	,,	8	5	0
Benzol, standard motor	per gal.		1	4
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	15	0
Carbolic Acid, crude 60's	per gal.		1	9
,, ,, crystallized, 40°	per lb.			6½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.		1	2
Copper Sulphate	per ton	18	5	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5½
Cresylic Acid, 98-100%	,,		1	6
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	1	6
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	0	0
Lead, Acetate, white	,,	42	10	0
,, Nitrate (ton lots)	,,	28	10	0
,, Oxide, Litharge	,,	32	0	0
,, White	,,	41	0	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey, 80%	,,	12	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	4	10	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	10	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	5	0
Potassium Bichromate	per lb.			5
,, Carbonate, 96/98%	per ton	29	10	0
,, Chlorate	,,	34	0	0
,, Chloride 80%	,,	11	10	0
,, Ethyl Xanthate	per 100 kilos	7	10	0
,, Hydrate (Caustic) 88/90%	per ton	39	10	0
,, Nitrate	,,	31	0	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	,,			8½
,, ,, Red	,,		2	0
,, Sulphate, 90%	per ton	13	0	0
Sodium Acetate	,,	22	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	29	0	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	7	4	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	8	16	0
,, Phosphate, comml.	,,	13	0	0
,, Prussiate	per lb.			5¼
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt Cake)	,,	3	1	0
,, Sulphide Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	12	0	0
,, Roll	,,	12	0	0
Sulphuric Acid, 168° Tw.	,,	4	5	0
,, ,, free from Arsenic, 140° Tw.	,,	3	0	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	7	0
Tartaric Acid	per lb.		1	1¼
Turpentine	per ton	55	10	0
Tin Crystals	per lb.		1	0
Titanous Chloride	,,			10¾
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

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

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	2 6	2 9
Esperanza Copper	13 9	13 9
Indian (2s.)	1 0	1 0
Loangwa (5s.), Rhodesia	1 6	1 9
Luiri (5s.), Rhodesia	2 6	3 3
Messina (5s.), Transvaal	6 6	6 0
Mount Lyell, Tasmania	17 0	16 0
Namaqua (£2), Cape Province	3 9	3 6
Rhodesia-Katanga	11 3	11 3
Rio Tinto (£5), Spain	14 10 0	17 17 6
Roan Antelope (5s.), Rhodesia	7 3	7 9
Tanganyika Con.	18 6	1 2 0
Tharsis (£2), Spain	2 13 6	3 5 0

LEAD-ZINC:	Feb. 10, 1932.	Mar. 10, 1932.
	£ s. d.	£ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	12 0	11 9
Broken Hill, North, N.S.W.	2 13 9	2 12 6
Broken Hill South, N.S.W.	1 13 9	1 15 0
Burma Corporation (10 rupees)	8 6	9 0
Electrolytic Zinc Pref., Tasmania	17 6	17 6
Mount Isa, Queensland	10 6	10 6
Rhodesia Broken Hill (5s.)	1 0	1 0
San Francisco (10s.), Mexico	7 6	8 9
Sulphide Corporation (15s.), N.S.W.	8 6	8 6
ditto, Pref.	10 6	10 9
Zinc Corporation (10s.), N.S.W.	1 3 9	1 3 0
ditto, Pref.	2 15 0	2 15 0

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	7 6	6 3
Consolidated of S.W.A. (10s.)	2 6	2 0
De Beers Deferred (£2 10s.)	3 11 3	3 15 0
Jagersfontein	16 9	1 0 0
Premier Preferred (5s.)	1 3 0	1 3 9

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

SAND-FILLING AT A CUMBERLAND MINE

Sand-filling at Hodbarrow hæmatite mine, Cumberland, is described by A. A. Jones in the *Bulletin* of the Institution of Mining and Metallurgy for February. The author says that at Hodbarrow sand-filling came into use as the result of observations on the effect of too-rapid caving of the Lower Carboniferous limestone and the Glacial clays and sands above it. These observations suggested that, had caving been allowed to proceed at a normal rate, although the limestone would indeed have fractured, chiefly under tension, the broken rock would have sufficiently filled the void to allow only bending without fracture of the impervious boulder clay lying immediately above the limestone. The mine has not been free from abnormal inrushes of sea-water into the southern area of the ore reserves. Well over a million tons of ore at the north and south ends of the property were rendered unworkable by the old caving system, and unless some scheme of working could be devised that would minimize subsidence, Hodbarrow was faced with the necessity for being shut down. The management of the mine were not long in recognizing that controlled sand-filling offered a solution to this problem.

Sand-filling consists of the transport of sand, by water, from surface to the site of ore extraction underground; it is therefore more aptly termed "hydraulic stowing." On the Continent of Europe the stowage consists of a great variety of materials, among which may be cited sand, gravel, burnt slate, boiler ash, flue dust, granulated slag, sandstone, with mine and washery waste. In many cases the preparation of the stowage for hydraulic transport involves the use of crushing and screening machinery, as a separate unit, constantly in action. In South Africa, the material consists of the sharp quartz tailings from the waste dumps; in this case the engineers' chief concern is the elimination of cyanide, generally effected by washing the filling material with a solution of $KMnO_4$. In contradistinction to the initial difficulties of both the Continental and the Transvaal engineers, at Hodbarrow there are ideal conditions for sand-filling at a minimum of initial capital outlay.

The subject is dealt with under the following headings:

(1) Form of conduits between surface and underground.
(2) The filling material and its characteristics.
(3) Arrangements at surface.
(4) Distribution of the sand to the voids underground. (*a*) By launders, (*b*) By pipes, (*c*) By pipes with aeration.
(5) Signalling apparatus.
(6) Preparing a void or "robbery" for filling.
(7) Special precautions.

(1) *Form of Conduits between Surface and Underground.*—For conducting the filling material to one area the shaft (No. 1 Pit) close by, is used. Here 8-in. loose flanged seamless steel pipes conduct the filling mixture to a point 240 ft. below the surface. In another area two bore-holes, especially sunk for the purpose at a cost of approximately £1 per foot, provided access for the filling to the mine workings 350 ft. below the surface. Both bore-holes are lined with steel tubing ¼-in. thick. No. 1 hole provides an effective internal diameter of 7¼ in., and No. 2 a diameter of 9 in. No. 3 hole, with a diameter of 8 in., acts for the time being as a conduit for signalling cables, which until No. 3 hole was sunk were subjected to heavy wear by passing down the other holes.

(2) *The Filling Material and its Characteristics.*—Lying below the 200 acres reclaimed from the sea by the outer barrier, and covered by nothing more formidable than marram grass and similar vegetation, are almost unlimited quantities of sand for filling purposes. When examined through a lens the sand grains are seen to be thoroughly rounded, and to be chiefly quartz. On an average, about three grains side by side would occupy a millimetre. With such a material the scour of pipes and launders is at a minimum, in contrast with the abrasive qualities of the banket tailings used on the Witwatersrand.

(3) *Arrangements at Surface.*—When, as in this case, the filling material does not require any treatment prior to distribution underground, the arrangements at surface are very simple, and resolve themselves into two stages:

(i) The early stage, when the sand which surrounds the collar of the bore-hole simply requires washing into the hole, and

(ii) The second stage, when sand has to be collected by some mechanical means and then washed down the bore-hole.

In the initial stages of sand-filling, before mechanical handling became necessary, sand is spaded or grabbed from around about the bore-hole tubes for a depth of a yard with a radius of approximately 20 ft. This yard of exposed bore-hole tube is then cut off by an oxy-acetylene jet, and covered by an iron plate ¼ in. thick, punched with ¾ in. holes. Sand is then washed into the holes by a jet of water, until a saucer-like depression is formed about the bore-hole. This process is repeated until the bore-hole tubes are cut down to a depth of about 16 ft., equivalent to 1 ft. into the clay below. The cross-sectional shape of this saucer-like depression is governed by the minimum slope that can be allowed for the launders that conduct the sand and water from the sand face to the bore-hole. An inclination of 5° from the horizontal has been found to be the flattest slope allowable for the launders, and at this gradient any mixture of sand and water exceeding 35% of sand (by volume) will have difficulty in flowing freely. Theoretically, the

amount of sand that is accessible in the early stages is represented by the volume of an inverted cone, whose height is 15 ft., and whose sides slope at 5° from the horizontal. This gives a volume of 17,100 cub. yd. of sand, which is sufficient to replace 57,710 tons of hæmatite ore. In practice, however, the amount of sand available will be very much in excess of this, due to irregularities, such as sand-dunes, which occur above the plane of the base of this imaginary inverted cone.

The water supply for both of the holes consists of a service taken from the discharge of the Cornish pumps by a 4-in. main which, commencing at a point close by No. 8 Pit, goes across the "enclosed area," a distance of approximately 2,000 ft., to a point between the bore-holes. On this supply there is an effective head of 45 ft. between source and discharge. According to Hawksley's formula these conditions should give 120 gallons per minute from this 4-in. main, divided between the bore-holes. This is not enough water when both holes are in operation at once. Each bore-hole should have a minimum supply of 100 gallons per minute. To attain this amount of water an additional supply has been arranged for by establishing a pumping station at the edge of the drainage pond, equipped with an electrically-driven centrifugal pump that can, if needed, deliver 300 gallons per minute.

The surface lay-out at one area is designed to allow entirely for the mechanical dumping of the filling material. Adjacent to the collar of No. 1 Pit a rectangular pit or bunker was excavated measuring 100 ft. by 20 ft., 15 ft. deep at the shaft end and 9 ft. at the far end. This was completely lined with brick and reinforced with brick abutments within. The bottom has a general gradient declining to the shaft, with a central gully having a gradient of 1 in 7 for conducting the sand and water mixture. Within 10 ft. of the shaft retaining wall of this sand-bunker the bottom is covered by an iron screen punched with 1-in. holes. Two jets of water are supplied from a 3-in. pipe. One nozzle plays continuously on the mixture as it passes from the bunker to the shaft conduit, the other is directed on the pile of sand by the man on duty. This bunker is almost 100 ft. long, and it is now realized that one-half of this length would have been enough, for the reason that, to effect rapid filling, the sand should be dumped right on the screen, as near as possible to the shaft conduit. If the sand-water mixture has to travel far before reaching the shaft conduit, much of the sand banks up against any foreign matter, resulting in a weak mixture reaching the shaft. One way of mitigating this would be to introduce powerful jets of water up the entire length of the central gully, but this is not possible because the water supply at this point is restricted.

(4) *Distribution of the Sand Underground.*—In the early days of sand-filling at Hodbarrow launders were used for distributing the sand to the filling site. It soon became evident that this form of "gravity" filling had serious limitations, by reason of (i) The inclination necessary for launders, and (ii) the height of the mine workings through which the launders had to pass. With such serious limitations to the use of launders more efficient methods of filling had to be devised.

The next development was to make use of the momentum caused by the descent of the fluid in the bore-hole, and if possible to use this impetus to get the filling further away from the bore-hole. A special casting was attached to the tubing in the bore-hole, "special" because this casting had to provide an exit for the signalling cable as well as for the sand. From this casting pipes were led to the site of the filling. The pipes used were of 4 in. internal diam., fitted with Victaulic joints, and laid with a gradient of not less than 1° from the horizontal. The use of pipes certainly trebled the radius of operation from the bore-hole, but against this advantage there was introduced the possibility of having to deal with a choked bore-hole or pipe-line. The volume of sand delivered per unit of time showed no improvement on the launder method for the reason that in use about two-thirds of the cross-sectional area of the pipe was occupied by sand except close to the discharge end. Filling was at such a slow rate that the process could not keep pace with ore-extraction, so that a means had to be found to utilize the full cross-sectional area of the filling pipes. After consideration of other schemes the introduction of a form of agitation induced by compressed air was tried and adopted.

The introduction of compressed air into the delivery line at a pressure of 60 to 70 lb. per sq. in. is a simple matter. With compressed air in use for machine drills, such motive force is always conveniently accessible for a sand-filling line. The injector finally used minimized the sand-blasting effect by injecting the air at a bend, in such a manner that the force was directed along the centre line of the pipe on the discharge side of the bend. It also became necessary to have a straight-line injector. A disadvantage of this design is the obstruction that the jet offers to the flow of mixture, due to the fact that it must be accurately aligned along the centre line of the tube. The result of aerating the delivery line has been eminently satisfactory :

(i) It has eliminated, with reasonable care, the possibility of choked pipes, which were formerly a feature of frequent and costly delay.

(ii) Consequent upon this, it is now possible to feed a mixture containing a minimum of water. A mixture that has less than 50% of sand, by volume, is rarely fed.

(iii) Aeration has made it possible to deliver the filling by routes that may have considerable up-grades in them.

(iv) It has extended the radii of operation from the bore-hole or shaft to, as yet, unknown limits. The longest length of pipe line so far (May, 1930) used at Hodbarrow measured 300 yd. ; its meanderings included many bends, 100 yd. of up-gradient of about 1 in 100, with 3 injectors more or less evenly spaced.

(5) *Signalling Apparatus.*—The importance of an efficient signalling system cannot be too strongly emphasized. Moreover, it should be maintained under the direction of a qualified and experienced electrician, who should have a free hand to instal up-to-date apparatus that has been designed for the work. In the early days of sand-filling at Hodbarrow, signalling was effected by mechanical means. A clapper attached to a wire rope ran through the bore-hole to a lever handle at the bottom. Finally, however, the senior electrician was given orders to submit a scheme and provide, in that scheme, for two distinct circuits :—

(*a*) A telephone circuit to be in a stationary position underground.

(*b*) A portable bell circuit.

This represents as reliable a signalling circuit as could be designed for these particular conditions.

(6) *Preparing a Void or "Robbery" for Filling.*—In nine cases out of ten the miners will have taken the ore out for a distance rarely exceeding 50 ft., with cross-sectional dimensions of 10 ft. by 10 ft. For the purpose of the paper it is assumed that on one side of the void is a previous sand-fill; beneath is sand representing the filling of the height below. On the other side of the void there is ore that has to be "robbed" next. Above is ore. The sand-filler's first care is to make sure that the miners have not left any tools or materials that could be used over again. He then runs out a strip of brattice cloth along any ore that may be exposed to view, taking care that the cloth sags well on to the ore between the timber legs or "forks." This is important, for, if stretched tightly from fork to fork, it will burst as soon as any weight of sand bears on it; for the purpose of the brattice cloth is to keep the sand off the ore when ore is in course of extraction from alongside the sand. Probably only the bottom width of brattice cloth will be put on first, and then a temporary dam can be erected at the entrance of the void. This is constructed by nailing 3-in. mining planks on to the outer side of the entrance forks, and lining the partition with brattice cloth, allowing a generous width of the cloth to lap over the sand floor. Next hay is used, which is an excellent filter. Apart from the crop of marram grass and its roots derived from the washing of sand at surface, all grass on the property is cut at hay-time and stacked for sand-filling purposes. Every possible outlet that the sand-filler can find is corked by a generous wad of hay, especially the extremities of the dam. The standing ore side is often broken, due to a subsidence that is unavoidable under some conditions, and the corner of a pillar so broken gives scope for ingenuity of the sand-filler. As soon as the bratticing has been finished and the dam erected, say, two planks high, he signals for water, followed after about 5 minutes by sand and water. It is then that the sand-filler has to keep keenly on the alert, and at any sign of sand getting past the dam he must stop and plug the leak.

(7) *Special Precautions.*—A set of rules issued by the author to the underground staff at Hodbarrow, as well as to all those connected with sand-filling, with a view to securing uniformity of practice throughout the mine by all concerned, are comprised under the following main headings:

Rules for Sand-Filling.—(*a*) *Rate of Filling.*—The author regrets that he is not able to give much information under this heading. The fluctuating and often vicious discharge of the sand-water mixture makes the taking of samples for water content a very difficult task. In one area the following figures were obtained, the surveyor carefully measuring the cubic contents of a "robbery" before it was sand-filled, and noting the exact time that the sand-water mixture was discharging: A void of 1,786 cub. ft. was filled in 16 hours and 5 minutes, equivalent to 112 cub. ft. or 6 tons of sand per hour. Adding the time taken for stops and bratticing, a void of this size would be filled in 3 working shifts of 8 hours each. 1,786 cub. ft. represents about 220 tons of hæmatite ore in place, and in this particular instance, by the old hand-drilling methods this amount of ore would take about 7 weeks to "rob." The same quantity of ore in another area would take about 3 weeks to extract by machine-drilling. This means that in one area the "robbing" of ore is 25 times slower than filling, and in another 11 times slower than filling. There are, however, many variable factors which may contribute to an alteration of these data, and not least of those retarding the speed of filling are those enumerated below under the heading of :—

Difficulties.—The chief difficulty that the management at Hodbarrow are always fighting is the leakage of sand from dams. Careless work in this respect at the outset will mean an irretrievable loss of time in trying to stem the leak and cleaning up the overflow. Another difficulty is the almost imperceptible but continual seepage of sand and rain-water down a bore-hole or shaft conduit. Such seepage is very difficult to stop at surface and a heavy rain storm during the week-end will wash a great quantity of sand down below, entailing a costly clean-up on Monday morning. Any attempt to plug the bore-holes at surface involves the difficulty of sealing a hole through which a signalling cable is hanging. To obviate this the discharge end of the pipe underground is left in a place, such as an old stope, or blind heading, where this seepage may be deposited without the need for cleaning it up. Sand-filling in wet ground is a difficult proposition, inasmuch as sand containing more than about 15% moisture is approaching the "quick" stage, and it would be superfluous to enlarge here upon the dangers of dealing with quick-sand in a mine. The amount of sand that finds its way to the drains feeding the pumps on the bottom level would be very small if examined each shift, but the accumulative process of a little sand day by day hastens the wear of the impellers of certain auxiliary centrifugal pumps that are in use underground. If the mine drainage system were entirely dependent on the centrifugal or turbine type of pumps, pumping costs would be abnormally high. It is fortunate that the mine depends chiefly on the Cornish type of plunger pump for drainage.

(*b*) *Timber Economy.*—That there is economy in timber where sand-filling is practised is certain, though it might not be apparent to the casual observer. It is rarely possible, or indeed worth the time expended, to extract the head-trees or caps from the sand-filled height below, and this is only done in isolated cases where the miners find that the caps come out easily. By the old top-slice caving method much timber was used in keeping open the last strip of "robbed" ground. When sand-filling follows "robbing" almost immediately, there is not only no need for this but the size of timber is reduced, and in some instances "forks" are split. So that the amount of larch necessary for extracting a given quantity of ore under sand-filling conditions is rather more than half that required for the same amount won by caving.

(*c*) *Subsidence.*—While subsidence was expected and encouraged under caving methods, it is now reduced by sand-filling methods to about 5%, and half of this may be due to the natural settlement and compressibility of the sand. In the areas where the ore mass does not yield readily to tensile strain, the amount of subsidence will be nearer to 3%, due entirely to the compressibility of the filling. Where the ore is much broken and has yielded to the strain due to the caving of the past, the amount of subsidence due to compression of the filling is augmented by the crushing of the top spiling or lagging on to the filling.

VENTILATION AT THE ROBINSON DEEP

At the time of the amalgamation of the Village Deep and the Robinson Deep mines a general investigation of ventilation conditions was undertaken, which resulted in a certain amount of re-organization. Part of the work involved a study of the distribution of the fan pressure on the Turf Shaft Section of the Robinson Deep and details of this survey are given by J. P. Rees and E. C. Whittaker, in the *Journal* of the South African Institute of Engineers for January.

At the time of the survey the ventilation was produced by a Sirocco fan at a water gauge of 10·0 in. The fan was situated underground on the return side of the mine, drawing the air from the surface through the intakes and working places and expelling it through the return airways back to the surface. The ventilation circuit consisted of intakes, working places, fan drifts and returns. These are described and defined as follows :—

The Intakes consist of (1) a vertical rectangular timbered shaft 4,000 ft. deep ; (2) a main incline shaft 3,500 ft. long, and (3) two parallel sub-incline shafts, approximately 2,000 ft. long. These sections are in series, the total length of intakes being 9,500 ft.

The Working Places designate, for the purpose of the paper, the area between the sub-inclines and the fan. The air leaves the sub-incline through seven splits, which carry it east and west to the development ends and stopes. Above the working stopes, and occupying about an equal distance, there is a large number of paths for the air through worked-out stopes leading towards the fan drift.

The Fan Drifts include the drives, cross-cuts and winzes in which the air is concentrated above and below the fan. These lie on and between 16 level and 15 level. The fan itself is in a winze connecting 16 and 15 levels.

The Returns are here defined as all the airways on the pressure side of the fan. That is all the airways above 15 level through which the air travels to the surface. Much of the air goes east through old stopes and shafts, and the remainder goes up No. 2 Incline Shaft and No. 2 Vertical Shaft.

The survey had as its immediate object to allocate to each of the above sections of the ventilation circuit the proportion of the total force developed by the fan which is used in getting the air through each section. A further object was to arrive at a decision on the best method of increasing the quantity of air flowing through the working places.

Method.—(*a*) *Principle.*—The method adopted was very simple, namely, to measure the rise or fall of the barometer at selected stations, when the fan was stopped. For instance, a barometer was installed temporarily on 18 shaft station at the bottom of the vertical shaft. On stopping the fan it was found that the barometer rose 0·145 in. of mercury, equivalent to 2 in. of water. It was, therefore, deduced that the fan, when running, produced a suction of 2 in. of water gauge at this point.

(*b*) *Instruments Used.*—The instruments used were ordinary aneroid barometers, a Paulin aneroid barometer and a syphon type mercury barometer. The ordinary aneroid was used first, but it was thought it might not be giving reliable results owing to the fact that with a falling barometer it suffers from a slight lag, due to the imperfect elasticity of the metal drums. A Paulin aneroid was, therefore, obtained from Sweden. In this instrument the amount of movement of a micrometer screw necessary to keep the diaphragm of the drums in a constant position is measured. The effect of the imperfect elasticity of the metal drums is therefore largely, if not entirely, eliminated. Later, it was thought wise to check the accuracy and reliability of the Paulin and ordinary aneroids by means of a mercury barometer. The syphon type was chosen as being sufficiently accurate for the purpose and quite cheap. Difficulty was experienced in getting the barometer filled with dry, air-free, mercury, but eventually, this was successfully accomplished.

Details of Procedure.—On arrival at the station where the measurements were to be made, the instruments were got ready and left for about a quarter of an hour in order that they should warm up to the surrounding temperature conditions. The instruments were then read and checked by two observers, the temperature of the air also being read. The fan was then stopped, according to a pre-arranged time table. As soon as the stoppage of the fan was observed to have taken place, the time was noted and about 20 minutes allowed to lapse, so that the ventilation conditions could become quite stable. The barometers were again read and checked, and the temperature of the air taken. The fan was then started and the readings repeated. The full round of measurement took about two hours, and was generally done at night. This procedure had four advantages :—

(1) The mean of the first and last readings corresponded approximately in time to the middle reading, when the fan was stopped. Changes in pressure at the surface were thereby eliminated. Nevertheless, these changes were checked by readings of the barometer at the surface.

(2) The readings being taken at fixed stations, there were no troublesome corrections for change in level, such as are necessary if a continuous survey of the barometric pressure is made throughout the ventilation circuit.

(3) Similarly there were no corrections for changes in air temperature or vapour pressure, since these were not altered during the period of about one hour that the fan was stopped.

(4) The effect of the pressure of natural ventilation was eliminated, and only the change in pressure produced by the fan measured.

With the help of magnifying glasses it was found possible to read the barometers to less than 0·01 in. mercury, but comparison of the readings shows that an accuracy of + or — 0·01 in. mercury is all that was attained in some cases. The results are therefore accurate to $\frac{1}{4}$ in. water guage. Compared to the accuracy with which the water gauge of a fan can be measured, or with which velocity pressure can be measured, this may be considered a disappointing result, but it was sufficiently accurate for the purpose of the survey. A more accurate method has since been devised by one of the authors and used on another mine, in a case where greater accuracy was desirable.

In addition to the precautions already mentioned the velocity of the air was noticed at the point of observation. The readings at different stations

should be made with the same velocity of the air, owing to the fact that the static pressure is being observed. A high velocity reduces the pressure, and the velocity head should, therefore, be added to the readings. The correction for differences of velocity of less than 1,000 ft. a minute comes well within the experimental error, and in this survey the only high velocities encountered were in the fan drifts. The necessary corrections were made to the readings in these drifts.

The course of the air may be altered when the fan is stopped. Anomalous results will then be obtained. An example in this survey was met with at observation point No. 9 and investigations of the flow of the air with and without the fan was necessary to make the results intelligible.

RESULTS.—The main results are expressed in the form of two tables below. Table I gives the actual pressure lost and the percentage pressure lost by each section.

TABLE I

Section.	*Actual Press. lost inches W.G.*	*% Press. lost.*	*Approximate length of section, ft.*
Intakes	3·9	40	9,500
Working Places	·1	1	7,500
Fan Drifts	3·8	38	2,000
Returns	2·1	21	4,000
Pressure produced by Fan	9·9 in.	100%	23,000

Table II gives the actual power consumed and the percentage power consumed by each section.

TABLE II

Section.	*Actual power consumed, horse power.*	*Power consumed %*	*Approximate length of section, feet.*
Intakes	126	25	9,500
Working Places	4	1	7,500
Fan Drifts	190	38	2,000
Returns	90	18	4,000
Total	410	82	23,000
Power put into air by fan	500	100	
Power lost by leakage (by difference)	90	18	

The power used in getting the air through each section was obtained by multiplying the pressure lost in lb. per sq. ft. by the volume passing in cu. ft. per minute. If there were no leakages, and the same mass of air flowed through each section of the mine, the sum of the power used in different sections would equal the power put into the air by the fan. The difference is the power consumed in getting the air through leakages.

In both the above tables the most striking features are the low figures for the working places and the high figures for the fan drifts. The working places were fed from seven splits. These splits, and further splitting through the stopes reduced the velocity of the air to such an extent that the pressure losses were merely nominal. Very roughly the pressure losses vary inversely as the square of the number of splits for the same volume of air. Hence, the losses through the working places are of the order of 1-50th of the losses in the parallel section of the intake, where they are about 2 in. of water gauge. Looked at in this way, the results which at first appeared irregular were seen to fit in well with the other readings. In the fan drifts the air that entered the mine was augmented by compressed air, by evaporated water and by leakage around the fan. The velocities were actually higher than anywhere else in the mine. The pressure loss and power consumed were correspondingly great. Table III gives the position and change in pressure at each point of observation.

Discussion.—The changes at points Nos. 6 and 7 up to 9·9 in. water gauge, compared to 9·7 in. water gauge found by a direct reading across the fan. However, on stopping the fan a direct reading of 0·3 in. water gauge was recorded, indicating that the pressure was 0·3 in. higher on the intake side of the fan. The corrected reading for the water gauge is, therefore, 10·0 in. compared to 10·1 in. claimed for the fan by the makers.

TABLE III

No.	*Position.*	*Change in pressure inches—water gauge.*	*Length of airways feet.*
1.	Top of Main Incline, 18 Station corresponding to bottom of Turf Vertical	—2 in.	4,000
2	32 Station Main Incline, corresponding to bottom of Main Incline	—3·6 in.	3,500
3.	40 Station West Sub-incline, corresponding to bottom of Sub-inclines and Intakes	—3·9 in.	2,000
4.	32 level East, above working stopes	—3·9 in.	3,000
5.	16 level East, beginning of fan drift	—4·0 in.	3,500
6.	16 level, just below fan	—6·3 in.	1,200
7.	15½ level, just above fan	+3·6 in.	—
8.	15 level, No. 2 Incline, corresponding to end of fan drifts	+2·1 in.	800
9.	2 Station, No. 2 Vertical, bottom of No. 2 Vertical and top of No. 2 Incline	—	2,600

On 16 level a cross-cut connects the Turf Vertical shaft to the fan drift. The pressure across the two doors in this cross-cut was 3·4 in. of water, when the fan was running, and about half an inch when natural ventilation alone was operating. According to the above results the fan pressure on the doors should be about 3 in., so that this result tallies, and is an independent check on the other readings.

At observation point No. 9, no definite change in pressure was obtained on stopping the fan. This point is at the bottom of No. 2 Vertical shaft, where the air upcasts to the surface. Observations were therefore made at the shaft collar of the quantity of air issuing. The quantity with fan running was found to be 120,000 C.F.M., and with fan stopped 100,000 C.F.M. It was thus clear that the pressure necessary to force the additional

volume of 20,000 C.F.M. through the shaft was negligible. But when the fan was running the total volume leaving the mine was about 280,000 C.F.M. Of this volume about 160,000 found its way out through No. 1 Village Deep Shaft, Village Main Shaft, and the eastern outcrops. This was a much longer route to the surface, and the temperature of the air must have fallen to a greater extent than in No. 2 Vertical, since the rock was cooling the air. Hence the pull of natural ventilation was much greater on No. 2 Vertical, and when the fan was stopped most of the air came out through this shaft, and only about 60,000 C.F.M. through the other exits.

Conclusions.—A survey of this kind shows in a clear and direct manner the distribution of the force and power put into the air by the fan. It is not intended to draw out detailed conclusions as to the best way of improving the distribution of the fan pressure, but the results showed that the fan drifts were absorbing too much force and power. By a suitable re-arrangement, this has been avoided, and the quantity of air circulating in the working places increased about 50%. The cost of power being known, it is easy to see from such a survey as this, the cost of leakage and the saving that can be effected by reducing it.

THE MEASUREMENT OF REFRACTORINESS

In the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa for December Dr. H. A. White endeavours to provide a measure of refractoriness. He says that in many branches of metallurgy some otherwise available ores are spoken of as refractory and this generally means that they are less than usually amenable to the known processes of extraction. The object of his paper is to provide a measure of refractoriness which shall be applicable to most cases, but more particularly to the various banket ores of the Witwatersrand, which differ in this respect though the economic significance is not great. In general, refractoriness is due to peculiarly intimate association of the valuable metal with one or more constituents of the ore, and where fusion methods are employed, which in effect reduce the ore to molecules the term is no longer applicable. In cases where the ore must be broken into fine particles to free the valuable constituents the degree of fineness required is in some sense a rough measure of the refractoriness. Further, it is a feasible proposition with modern appliances to crush ore to a fineness of 200 mesh (74 microns in diameter) without unreasonably excessive cost, and indeed in a few cases 350 mesh grinding is in actual use.

Taking the above facts into consideration it is proposed to define refractoriness as a function of the residual fraction, after usual treatment, when all the ore of unit value is crushed to pass 200 mesh screens. Thus any ore of unit value which yielded no extraction at all in this case would have a refractoriness R = 1·00, and if the residue were 0·4 of the original unit value then R = 0·40. Most ores, to be treated by other than fusion methods to free the valuable constituent, are crushed to from 40 to 100 % −200 as the final pulp grading, and to estimate the relative refractoriness from the residue values it is necessary to know how these vary with the original value and with the fraction of −200 material in the crushed ore.

It is generally admitted that a higher extraction percentage may be recovered from rich ores than from poor ones of a similar nature, but the author is not aware that any formula has been published which will show the difference with moderate accuracy. It is also admitted that with higher values in the originals somewhat higher residues are to be expected, but not in proportion or the former principle would not hold. Upon consideration of published figures for gold ores it appears that the residue depends, other things being equal, upon $\sqrt{O}$ where O is the value of the ore in pennyweights per ton. Thus if a 10 dwt. ore gave a residue after usual treatment of 0·40 dwt. it would be expected to find the residue drop down to $\frac{\sqrt{5}}{\sqrt{10}} \times 0{\cdot}40$ or 0·28 dwt. if the grade dropped to 5 dwt. and nothing else had been changed. Similarly if a 6·25 dwt. ore shows a residue value of 0·35 dwt., the sorted waste of a value of 0·5 dwt. on the same mine would give a residue value of $\frac{\sqrt{\cdot 5}}{\sqrt{6{\cdot}25}} \times 0{\cdot}35$ = 0·10 dwt., if separately treated in the same manner and the refractoriness remained unchanged. The extractions in the two cases would therefore be 94·4% and 80% respectively and viewed in this light it will generally be found that the waste mined with banket ore is frequently less refractory than the ore itself, though the difference is not of much significance.

In addition to the effect of the original value upon the residue the effect of the percentage of −200 in the final pulp has to be considered. Here again one can only deal with one's experience of variation in this respect and in the case of banket ores an abundant supply of material is at hand, as very many mines have increased the proportion of −200 mesh in the final product as a result of the introduction of tube-milling in one, two, or even three stages. For these comparisons it is well to take a whole year's figures if possible, as a seasonal variation is marked in some cases. In this way it appears that the residue value depends upon $\frac{1}{F^3}$ where F is the fraction of −200 grade in the final pulp. It may be noted that no very considerable effect is to be found with Rand ores, even if the pyritic portion is specially selected for preferential treatment, beyond that usually associated with water classification. Of course, in many cases fine grinding has been associated with a greater proportion of the ore being treated in the slimes plant, but fortunately the resulting formula may be tested, free from this complication, by utilizing the figures available from the all-sliming plants; especially where two-stage tube-milling or the introduction of the composite steel pebble load for tube-mills has given a significant variation to the residues and the fraction of −200 grade produced.

After considering the effect of the original value and proportion of −200, the formula becomes $R = \frac{F^3 D}{\sqrt{O}}$, where R is refractory index, F is fraction of −200 grade in final pulp, D is residue value and O original ore value in dwt. per ton. For illustration we may take a platinum ore: original value 4·5 dwt., residue 0·55 dwt., crushed to 68% −200

$$R = \frac{F^3D}{\sqrt{O}} = \frac{\cdot 3144 \times 0{\cdot}55}{\sqrt{4{\cdot}5}} = \cdot 0815$$

Therefore the refractoriness is ·0815 and consequently if the ore were crushed to 100% − 200 and other things remained equal the residue would be

$$\cdot 0815 \times \sqrt{4{\cdot}5} = 0{\cdot}17 \text{ dwt.}$$

with an extraction of 96·22% against 87·78% with a grading of 68% − 200. Taking the figures for West Springs published by Messrs. Willey & Ewing in the *Journal* for October, 1929, we have :—

Single-stage tube-milling : (R_1)
Original 6·891, residue 0·495, % − 200, 77·1
Double-stage tube-milling 10/2 (R_2)
Original 6·140, residue 0·386, % − 200, 79·3
Double-stage tube-milling 9/3 (R^3)
Original 5·968, residue 0·346, % − 200, 81·5
In these three cases in order

$$R_1 = \cdot 086,\ R_2 = \cdot 078,\ R_3 = \cdot 077$$

These are figures for three months only in each case and the average shows R = ·080. If therefore the ore were crushed to 100% − 200 and other things remained equal the residue would be

$$\cdot 080 \times \sqrt{5{\cdot}968} = 0{\cdot}19 \text{ dwts.}$$

and the extraction would increase from the latest figure of 94 20% to 96·80%. How far that would be profitable will be dealt with later on.

As a final illustration to compare with the typical Far East Rand ore of West Springs the case of the Princess Estate will be taken, which gave probably the most amenable ore on the Rand : original value 7·5 dwt., residue 0·18, % − 200, 60

$$R = \frac{\cdot 216 \times 0{\cdot}18}{\sqrt{7{\cdot}50}} = \cdot 0142$$

This would have given an extraction of 99·48% at 100% of −200 mesh against the 97·6% actually obtained.

The usefulness of this measurement of refractoriness is not exhausted in providing these more or less vain comparisons ; it can also be applied to determine in each case the limit to which fine grinding may be profitably carried. In order to effect this purpose the cost must first be determined, and a general formula is thus arrived at which may require small modifications to correspond with special cases. As a base Messrs. Willey & Ewing's declaration may be taken, in the paper already quoted, that the capacity of a tube-mill under similar conditions is reduced 10% for a 5% increase in percentage of −200 in the final pulp. This experience is I believe generally accepted as a close approximation all along the Reef.

Put into mathematical language this means $\delta(fx) = 2x$, and therefore $(fx) = x^2 \times$ a constant, and the cost of crushing varies as the square of the fraction of −200 in the final pulp or as F^2 in the notation now used. The constant to be employed will vary with the methods used and is lower in two-stage tube-milling as proved in the paper quoted. For present purposes we need only take the total tube-milling costs as other costs are not adversely affected by increasing percentage of −200 mesh, though some slight complication may be found where an increase in the proportion treated as slime will follow as in many of our older plants.

The abundant working details given enables one to make further use of the West Springs case and we find the latest cost published is 17·0 pence per ton for 81·5% − 200 with second-stage tube-milling. To this must be added 3·0 pence per ton for capital redemption and interest on tube-milling plant, giving a total of 20 pence per ton.

∴ Cost = C F^2 or $20 = C \times \cdot 815^2$ and C = 30 C may be called co-efficient of cost in pence.

Tube-milling costs may therefore be put at 30 F^2 pence per ton of ore or at 25·6 F^2 pence exclusive of interest and redemption. These are outside figures as some of the costs would not increase at all. It is obvious that the limit to which finer grinding may be carried is where cost plus residue value is a minimum. Beyond that point a loss is involved and up to that limit a gain is obtained. Residue value in money will be

$$\frac{R\sqrt{O}}{F^3} \times 50 \text{ pence}$$

Put in the form of an equation

$$30\ F^2 + \frac{R\%O}{F^3} \times 50 \text{ is a minimum}$$

when $60\ F - \frac{150\ R\sqrt{O}}{F^4} = 0$

or $F = \sqrt[5]{2{\cdot}5R\sqrt{O}}$.

Applying this formula to the case of West Springs we get

$$F = \sqrt[5]{2{\cdot}5 \times \cdot 080 \times \sqrt{6{\cdot}333}} = \cdot 8717$$

or neglecting capital charges

$$F = \sqrt[5]{2{\cdot}93 \times \cdot 080 \times \sqrt{6{\cdot}333}} = \cdot 8998$$

That is, it would pay to keep the grading down to anything less than 89·98% of −200 in case of shortage of ore or it would pay to increase the plant if the tonnage to be put through reduced the percentage of −200 to below 87·17%. In the former case the residue would drop down to

$$\frac{\cdot 080\sqrt{6{\cdot}333}}{\cdot 8998^3} = 0{\cdot}276 \text{ dwt.}$$

and extraction would increase from 94·2 to 95·6% at an increased cost equivalent to something less than the value of the extra gold won. Owing to the peculiar working of the formulae employed on Government leased mines it would actually pay the shareholders to carry the extraction a shade further than indicated even though the extra gold would cost a trifle more than its value.

On older mines, where capital increases are no longer economical owing to short life, it is still possible to increase percentage of −200 in final product by using a composite load of steel balls and pebbles in the tube-mills, if the motors will stand the extra power required, and by means of above formulae it will be possible to estimate approximately the residue value to be expected. The extra cost can of course be closely calculated in each case. The advantage to be obtained will in general depend upon the refractoriness as defined in this paper. In reduction plants where sand and slime are treated separately a more exact calculation may be obtained by taking into account a time factor, which so far has been ignored in this paper as it does not affect the position where all-sliming plants are concerned.

Time Factor.—For the small variations caused by the usual fluctuations in tonnage supplied to the mills, and even for the larger variation caused by chronic overloading of reduction plants, residues will vary approximately as square root of the time of treatment. In all-sliming plants this simply means that time of treatment varies inversely as the tonnage milled per day. Square root of time of treatment is calculated very simply and does not depend upon fineness of crushing in any way.

Where however sand and slime are treated separately the average square root of time of treatment will vary with the percentage of slime made even when the total tonnage remains unaltered. This is due to the fact that in general a much smaller time of treatment is allowed for slime, usually from a fifth to a tenth of that for sand. It is therefore obvious that where increased fineness of pulp is produced by changes in the mill a greater proportion of slime will be produced and the advantage in extraction will be offset to a small extent by the consequent reduction in average square root of time of treatment for the whole product.

The percentage of slime produced usually varies directly with percentage of −200 grade in final pulp and is generally from 105 to 110% thereof. Thus if final pulp contains 70% of −200 grade the percentage of slime will be 73 to 77%. Putting T for average time of treatment in days (that is square of mean square root) and F for fraction of −200 in final pulp, it is a mathematical deduction from foregoing assumptions that TF is a constant ∴ TF = c (where c is co-efficient of time) (assuming total tonnage is unchanged). The following figures for Geduld and Modder Deep illustrate the position.

	TF Geduld.	TF Modder Deep.
1924	2·015	2·632
1925	2·179	2·641
1926	2·137	2·665
1927	2·049	2·618
1928	2·047	2·694
1929	2·087	2·616
1930	2·202	2·605
Average	2·102	2·642

These figures were adjusted for variation in total tons milled and naturally the remaining variations are principally due to changes in classification employed.

In order to deal with the time factor mathematically we extend the definition of refractory index to include treatment for unit time and we get

$$R_T = R\sqrt{T} = \frac{F^3 D\sqrt{T}}{\sqrt{O}}$$

and the new index is more fundamental inasmuch as it enables comparison between all-sliming and the older style reduction plants. An equation may be derived to determine the optimum fineness to which crushing may be carried in sand and slime plants with the following result :—

$$F^2 = \frac{62{\cdot}5}{C\sqrt{c}} R_T \sqrt{O}$$

where F is the fraction of −200 grade in final pulp :—

C is co-efficient of Cost in pence,
c is co-efficient of Time in days,
R_T is Refractory co-efficient including time effect,
O is Original Value of ore in dwt.

In order to give a definite picture of results of applying above methods a rough calculation as near as available figures will permit for a few mines—particularly those of the Rar East Rand is given—in Table I. It appears to be likely that where the life warrants the necessary capital expenditure, finer grinding would in most cases be profitable, especially in the all-slime plants where treatment time is relatively short.

TABLE I

Mine.	R.	R_T	F. (opt.) % −200	Remarks.
Princess	·014	·04	65	
E.R.P.M.	·026	·05	70	
Modder Deep	·020	·04	70	
Modder "B"	·021	·04	70	
New States	·050	·05	85	All-slime.
Modder E.	·063	·06	85	All-slime.
Geduld	·048	·08	80	
West Springs	·080	·08	85	All-slime.
East Geduld	·080	·10	90	All-slime.
Springs (1925)	·053	·10	85	
Sub Nigel	·071	·10	90	

THE SHABANI ASBESTOS MINES, SOUTHERN RHODESIA

The geology of the Shabani mineral belt in Southern Rhodesia has been well known since the publication of the Southern Rhodesia Geological Survey Bulletin No. 12 by Dr. F. E. Keep, but some welcome details of operating practice at the asbestos mines are described by J. Spalding in the *Bulletin* of the Institution of Mining and Metallurgy for February. The author of this paper reminds us that Shabani is situated towards the southern edge of the Rhodesian "high veldt" or plateau, at a height of 3,000 ft. above sea-level. It is 130 miles by road from Bulawayo and 70 miles by rail from Gwelo, a junction on the Southern Rhodesia Railways main line, rather more than 700 miles from the seaport, Beira. The mines are in country consisting of a cluster of steep rounded hills or "kopjes," each a few hundred feet in height and for the most part fairly close together, so that there is seldom any level ground between. The country is covered with stunted trees and scrub, except on the serpentine belt, where the vegetation is more scanty. The rainfall at Shabani is less in quantity and more uncertain in incidence than in other parts of Southern Rhodesia, averaging 25 to 30 in. annually, while hot season temperatures are much higher, 110° in the shade occurring frequently. On winter nights slight frosts occur in the valleys. There are several farms flourishing near the mines; they depend, however, more on artificial irrigation from the rivers than on the rainfall. The Shabi or Sabi River runs parallel to and 1¼ miles from the ore deposits, but except during the rains, this is usually only a chain of isolated pools. The nearest perennial river is the Lundi, 7 miles away.

GEOLOGY.—The ore-bodies occur in a mass of serpentine which measures about ten miles by one mile. This is entirely surrounded by a talc-schist, which is in turn surrounded by gneissic granite. Originally dunite, this mass is partially altered to serpentine in the centre, completely so at the edges. The contact between the serpentine and the schist is generally indefinite, the one rock merging into the other. In some places, however, there is a well-defined contact, the local dip and strike of which frequently bear no relation to the general course of the contact. For instance, the general dip of the contact on the north-east edge of the serpentine is 25°, whereas in one locality the contact is disclosed as a series of horizontal and vertical planes,

giving a stepped effect. The dunite, the older rock, has been surrounded, and possibly floated, in a sea of later granite, magmatic waters from which then attacked the dunite at its edges and began the change to serpentine, working from the edge inwards. The asbestos seams were formed in cracks near the north-east contact by solution and re-precipitation of the serpentine by magmatic waters. The schist was formed later by a pressure alteration of the serpentine in the presence of magmatic emanations, and occurs all round the serpentine mass and in various shear-zones within the mass.

The seams of chrysotile asbestos are short discontinuous veins, most of which are roughly parallel, and dip slightly to the south-west. They are most frequent near the contact, becoming fewer and fewer toward the centre of the mass. The fibres generally are normal to the plane of the seam, though occasionally they lie at an angle. The length of fibres varies greatly, the maximum being about three inches, but most of the longer fibres have one or more "fractures" or weaknesses in them, and the average length of unfractured fibres is from one-half to three-quarters of an inch. There are frequently two or more bands of fibre in one seam separated by thin partings. Commercial fibre is pale green in colour, with a silky lustre, and has great tensile strength even after repeated acute bending. At the edges of the seams a green serpentine is usually developed with a characteristic granular fracture. This merges into normal blue-grey serpentine about an inch from the seam.

Approaching the schist from the serpentine mass, the seams become more numerous, but near to the contact the fibres are "harsh," like bristles, with decrease of tensile strength, and nearer still become definitely brittle. Brittle fibre can be detected at sight after some experience, being generally darker in colour, and less silky in appearance; it has no commercial value and, if milled, little of it survives the crushing. The brittle fibre zone averages about 20 ft. thick, but varies from nothing up to the whole width of the deposit. At the contact, where serpentine merges gradually into schist, seams of "pseudo-fibre," a talc-pseudomorph, are common. It is not unlike fossil wood in appearance. Occasionally brittle fibre and pseudo-fibre are observed in the same seam, the change often occurring in less than 6 in. Further into the schist the pseudo-seams die out, and the schist becomes increasingly soft towards the granite. The hanging-wall of the deposit is an economic one entirely, the footwall also being rather indefinite, at the change from "good" to brittle fibre. Near the surface the hanging-wall rock is characteristically seamed with many bands of magnesite, but this does not show to any extent in depth; it is generally greyer in colour and more jointed than the serpentine in the ore-body.

The ore-bodies occur over a length of about three miles in the middle of the north-east edge of the serpentine. The proportion of ore is about 4%, some zones yielding as much as 20%; 1% is roughly the economic minimum for quarrying. The average dip of contact and ore-bodies is 25° to the south-west. No commercial deposit of asbestos has been found on the opposite (south-west) side of the mass. The ore-bodies are separated, either by shear-zones and tongues of schist, or by barren zones, where complete serpentinization of the dunite has apparently not taken place. They are divided naturally into four groups, each of which is worked as a separate mine or section. That farthest west is known as Block 177, next comes Block 170, then the Birthday mine, and farthest east the Nil Desperandum. There are other prospects and old workings between and beyond these, but they are not being touched at present, and will not require investigation for many years. In the Nil Desperandum mine, and in depth in the Birthday and Block 170 mines, many intrusive tongues of schist break up what was originally one large ore-body into a number of isolated smaller bodies.

QUARRYING.—The first consideration in mining asbestos is to damage the fibres as little as possible. This is effected by separating most of the fibre from the rock as near to the working face as convenient, and by blasting short lightly-charged holes, in preference to longer ones with greater burden. Nearly all the output at Shabani is at present obtained by quarrying. Winzes are sunk in rows from surface 50 ft. or 60 ft. apart, connecting each way with cross-cuts on the level below. These winzes are kept nearly full of broken rock, and the ground is stoped out round them, the fibre being cobbed and bagged, and the rock thrown into the winzes. In some sections the fibre comes away easily from the rock in flat "cakes," in others it is "frozen on." The rock is drawn out into cars on the level below and hoisted to a rock-plant for the extraction of short fibre, fibre missed by the cobbers, and fines.

Holes are drilled downwards both by hand and by jackhammer 2½ ft. to 3 ft. in the former case 4 ft. in the latter. All work is on a task basis, that for hammer boys being three holes per shift, for machines 40 holes, with a bonus on footage exceeding that. Cobbing boys are given a task of 1,500 lb. per shift, and their product averages 40% to 50% asbestos. The bags of cobs are weighed in the quarry and then tipped out into a fibre winze, from which the cobs are trammed and hoisted separately. Holes are blasted at the lunch interval and at the end of the day's shift. In order to facilitate cobbing, the floor of the quarry is kept fairly flat, and as free as possible from broken rock, a certain amount of "lashing" or mucking into the winzes being necessary. Permanent gangs of lashing boys are kept for this purpose. They are usually raw boys, who are thus broken in on the surface until fit for harder or more skilled work. Holes are pointed by the white miner in charge, who also superintends lashing, cobbing, charging, and blasting. The working shift is nine hours, with a one-hour interval for lunch.

Overburden is removed in a similar manner to the ore, but is trammed and hoisted up separate overburden shafts. Later, to square up, level benches are carried, and the waste is lashed up and trammed in side-tipping V-trucks, of 1-ton capacity, to a bin directly over the shaft. The shaft-rails are continued up the side of the conical dump at an angle of 25° or 30°. The tipping apparatus for the self-dumping skips is carried on a boom projecting 30 ft. beyond the top of the dump, supported by steel ropes over a vertical frame, and steadied by various guy ropes. The boom is extended when necessary and a new vertical frame put in. This is accomplished in about 8 hours. This type of head-gear has proved very successful, although a certain amount of trouble is sometimes experienced at the commencement of the rainy season owing to the dumps settling unevenly.

Handling.—Tramming of quarry-stuff is best organized in Block 170, the output from the single large quarry being 42,000 tons per month. There are two main tramming drives, one on the hanging-wall and one on the foot-wall, connected by some 30 cross-cuts. Drives and cross-cuts are graded 1% for one-way traffic throughout. Trucks are filled in the cross-cuts, trammed along the foot-wall drive and tipped into the shaft bin, then elevated by a creeper, and so back along the hanging-wall drive to the cross-cuts. On all mines, both for quarry and development work, 16-lb. rails at 18 in. gauge are standard, though occasionally at stations and tips 24-lb. rails and points are used. Both U- and V-shaped side-tipping trucks are in use. Cars are filled from "Cousin Jack" boxes, but all shaft and transfer boxes are fitted with radial doors, and an iron chute as standard, mounted either in a timber or a concrete box front.

At Block 170 hoisting is effected up a long flat shaft or haulage driven at a small angle to the strike of the ore-body. Ten-ton skips are used, running on 45-lb. rails at a speed of 1,000 ft. per min. On the other mines, the shafts are approximately parallel to the dip, with 2- to 3-ton skips on 35-lb. rails. When required cobbed fibre from the fibre winzes is hoisted up a separate shaft.

Development.—On all four mines a considerable amount of development work has been done. All shafts are sunk parallel to the dip at inclinations of from 20° to 25°, and are equipped with 2-ton skips, running at a speed of 600 ft. to 700 ft. per min. Low-grade development-rock is hoisted and dumped into a small bin in the headgear, from which it is trammed by side-tipping trucks along the edge of the flat-topped dump and tipped. "Piccanins" or youngsters, working on the sides of the dump, sort out and bag any fibre. In producing sections, rich development-rock is sent to the mills, although much of the development-fibre is in the state of fines and fluff.

Levels are driven at vertical intervals of 100 ft., alternate levels being equipped with shaft bins, fitted with radial doors and measuring chutes. The intermediate levels feed direct into the bins through a transfer winze, also fitted with a radial door. The bins are covered by grizzleys, 12 ft. by 12 ft. or larger, formed of 35-lb. rails placed to give a 12-in. square opening. With this equipment an average hoisting speed of 25 skips per hour is accomplished by the native hoisting gangs and drivers, without immediate white supervision. The boys are checked and kept up to "scratch" with the help of Service recorders, which are fitted to all hoists.

The talc-schist is a very soft rock and permits rapid advance of faces at a low cost for explosives. However, away from the contact the ground becomes increasingly soft, frequently necessitating heavy timbering. In general, the farther from the contact the heavier the ground. So development in the foot-wall, whilst advisable from one point of view, must be laid out very circumspectly to avoid the expense of close timbering. Intrusive tongues of schist are not so soft and are usually ideal rock for development work. At each level a main drive is put out, roughly following the contact, and on the schist side of it. (On the serpentine side of the contact tough ground is frequently encountered.) From this drive cross-cuts are driven, at 180-ft. intervals, well through the body into the hanging-wall. Near the ends of these, winzes are sunk through the body to hole to the cross-cuts below. To prepare for stoping or quarrying operations intermediate cross-cuts are driven as required. All development is graded 1% towards the shafts. The deepest ore-body so far discovered is disclosed in the shaft of the Birthday mine at a depth of 650 ft. below the surface. This is cut off above and below by horizontal tongues of schist.

Cross-cuts and winzes are sampled at 5-ft. intervals by counting the number of seams of fibre exposed in 5 ft. of true width, and classifying them according to unfractured fibre length—e.g. 1 at 1¼ in., 2 at 1 in., 2 at ¾ in., 1 at ½ in., 5 at ¼ in. Winzes are sunk by hand-labour and average about 7 ft. a week; the hammer boys' task is to clean out the previous blast and drill two 2 ft. 6 in. holes. Hand-labour drives average 9 ft. a week (more when in schist), two or more holes per boy being pointed according to their hardness and direction. Except in schist, 60% gelignite is generally used in hammer-faces. For driving, each machine man is allotted two machines and rigs and one spare machine, with two or more faces, and with this he pulls two rounds per shift. In serpentine about seventeen 5½-ft. holes are required to pull a round, using a central four-hole cut; in schist as few as twelve 6-ft. holes will often break, leaving no sockets. Occasionally when in brittle-fibre ground the rock is considerably harder to drill and also breaks badly, as many as twenty holes being sometimes required. Machine men are paid by the day with a bonus of 2s. per foot and deductions for excessive explosives consumption. Machine- and spanner-boys are also paid by the day, with a bonus of 6d. and 3d. per foot respectively. Most machine-work is done on day-shift, and the faces are cleaned out at night. The average footage per machine-shift works out at over 4½ ft., and the consumption of explosives at 8 ft. per case. The highest explosive used is 60% gelignite, but 40% is issued for soft faces. The machine-man's gang consists of two machine-boys, two spanner-boys, one learner, and one drill- and magazine-boy. Machine- and spanner-boys come on shift half an hour before the machine-man and prepare to rig up. To drill and blast a round takes about 7 hours in good ground, up to 9 hours or more in brittle-fibre ground. Each mine has its own air-compressor, but all air-systems are interconnected, so that only one or two compressors are run at once. The pressure on surface is adjusted to 75 lb. per sq. in.

Stoping.—In mining asbestos it is of great importance to prevent wood-fibres becoming mixed with the asbestos-fibres, and therefore the less timber used in stopes the better, especially in positions where it is likely to be crushed or splintered. Another fact to be borne in mind when planning stoping operations is that the asbestos ore will not run in ore-passes unless they are vertical and of good size.

Production from stopes has been started in the Nil Desperandum mine. Cross-cuts are driven through the ore-body, and stopes are opened up above them and carried up with a flat-back by shrinkage for 100-ft. lifts. Stopes are 50 ft. or 60 ft. wide, with 30-ft. pillars between. After the stopes are complete, the pillars have to be stoped out, also by shrinkage. In the other mines at Shabani, the serpentine is much seamed and fissured in all directions, and stopes of the width rendered possible by the strong quality of the ground at the

Nil Desperandum mine are out of the question. Accordingly experiments have been started at the Birthday mine on two other methods of stoping. In one method the stopes are similar to those at the Nil Desperandum mine, but only 36 ft. wide with an irrecoverable 9-ft. pillar between the stopes. The stopes are carried up by shrinkage with a flat-back. The distance between the back of the cross-cut and the bottom of the stope was made 5 ft. at first, but was later increased to 8 ft., as, owing to the numerous fissures, the 5-ft. pillar did not stand. Travelling ways into the stopes are cut in the side of the pillar, and cribbed on the open side with round poles. The stopes will be carried up to within a few feet of the level above and then drawn off. The total percentage of ground not stoped and irrecoverable will thus be about 30%. As much fibre as possible is cobbed in the stopes, bagged, and is hoisted by a small air-winch up a ventilation-winze through the back of the stope, to the level above. The output expected from underground cobbing boys is 1,000 lb. per shift. A considerable amount of fibre is missed owing to its being buried in the pile, and to the lack of adequate illumination.

Box-holes are risen from the cross-cuts every 12½ ft. alternately on each side, and experiments have been made in the Birthday mine as to the best and cheapest kind of box. Rising is done with a C.P. 10 machine fitted with a telescopic air-feed back head, which was originally designed and made on the property. At the Nil Desperandum mine concrete box-fronts are used, moulded behind a one-piece iron-former, giving a rather restricted arched opening. Experiments on box-fronts without the arched top necessitated a more complicated former, a larger excavation, and therefore more concrete. Short square-timber legs were then tried hitched into the box-hole, but the ground was found to be too brittle, and hitches often broke away when holes were blasted nearby. Timber legs were then held in with pegs and grouted with cement, and this was found to make a cheap and simple box. However, further experiments showed that the best box was one made with concrete legs cast on surface, and very roughly hitched in and grouted. The cost of these boxes works out at less than £3 each, compared to £5 10s. for a Cousin Jack box. A gang of three boys cast twelve legs a shift on task, and the cost worked out at well under 5s. a leg.

The second method of stoping tried necessitates more development per ton mined, but should give cheaper stoping, better sorting, and less ore irrecoverable. Intermediate levels are driven and cross-cuts put out as usual; the intermediate level cross-cuts, however, are not driven vertically above the main-level ones, but staggered, so that the stopes over them come up underneath the pillar between the old stopes on the level above. It is intended that, when the stopes above cave in and the pillars collapse, the latter can be drawn off with the rock from the stopes below. To test this ten stopes have been laid out, four on the 1A Level, three on the 1st Level, two on the 2A Level, and one on the 2nd Level. In order that caved ground can be drawn off, boxes are not used, owing to the large pieces expected. Instead, every 30 ft. along one side of the cross-cuts, bull-dozing chambers are cut, 10 ft. wide. The bottom of the chamber is made 5 ft. above rail-level, and in continuation of it a platform is built over the cross-cut and supported on three cross-bearers. Two holes in the platform correspond with two trucks beneath. The other end of the chamber is connected by a 10-ft. by 6-ft. rise to the stope above. The rock from the stope runs through this and rills out to within a few feet of the holes in the platform. The intervening space is covered with a ½ in. iron sheet, so that very little labour is required to shovel the stuff from the rill into trucks below. All big rocks are broken here, and any fibre missed by the cobbers in the stope can be easily sorted. The stopes are 25 ft. wide, with a 9-ft. pillar between stopes, and are carried up by shrinkage with a back sloping 25° to 30° from the direction of dip. Stopes will be carried up through the old level above, till sufficiently close to the stopes above to ensure complete caving of the shell remaining. On neither of these two methods has sufficient work been done as yet to enable any decisions to be reached.

TREATMENT.—When laying out a mill it has been the practice at Shabani to plan it on the top of one of the numerous small kopjes, the shafts being laid out in such a way as to feed direct into a small bin over the mill. To handle the products a tunnel is driven under the kopje and inclined winzes with iron trough-chutes, or vertical winzes, with and without lifts, are holed to it, to transport loose or bagged fibre from the mill to the trains in the tunnel below. These trains are drawn by storage-battery locomotives running on 24-lb. rails, at 18-in. gauge. Tailings are conveyed on belts to a small bin, from which small skips are filled; these run up a conical dump and are tipped in a headgear similar to that used on over-burden dumps. Although the mills are usually situated in hills, they are laid out on a flat site, with elevators where necessary. This is done because there are very few data available as to asbestos milling, and after extended trials of a new mill, radical alterations and additions to the flow-sheet are often required. Nor is it certain that because one mill works efficiently an exactly similar one will also do so, because there are slight physical differences in the fibre from the various deposits and also in its condition on arrival at the mill, which necessitates modifications in the flow-sheet.

The treatment in itself is simple, consisting of crushing, drying, air-separation, and grading. It has been found that dry fibre which undergoes much handling gets rubbed up into a fluffy state, which causes difficulties in milling and is undesirable in manufacture. Accordingly all quarry-ore is kept well wetted, and the fibre arrives at the mill containing a considerable percentage of water, but in a comparatively undamaged condition. The moisture is driven off in driers, when partial separation has been effected. In one mill the driers are steam-heated, while in the others they consist of rotating cylinders in which the products of combustion of a wood-fire are in direct contact with the fibre.

Primary crushing is by jaw-breakers and rolls, with hand-picking between, resulting in three products—coarse waste (which goes direct to the dump), hand-cobs, and fines. The hand-cobs are sent direct to a special mill which treats all hand-cobbed fibre, both from working faces and from mills. Secondary crushing is in batteries of small grinding pans. The separation of fibre from rock, whether dry or damp, is effected by spreading the crushed ore in a thin stream on a wire screen, and passing it beneath a nozzle into which a current of

air is being drawn. Asbestos fibres and "prills" are picked up and pass into the air stream. The fibre in suspension in the air current is deposited in a centrifugal settler, the air passing on through the exhaust fan and dust-trap to an outlet. The sorted and cleaned fibre is sent to a central grading mill, where it is further cleaned from dust and is separated into the various marketable grades. These are defined by the percentage left on a series of standard screens in a testing machine. The grading is done in hexagonal trommels, rotating in a dust-tight casing connected to an exhaust fan.

The milling and grading being an exceedingly dusty business, much care is necessary to enclose the units and extract dust as soon as it is formed. It is very important also that dwelling houses, etc., should not be built to leeward of the mills' dust-vents.

MINERAL DEVELOPMENTS IN THE CANADIAN NORTH WEST

From time to time we have had occasion to refer to mineral developments in the Great Bear Lake-Coppermine River area in the Canadian North West Territories and in the *Canadian Mining Journal* for January an account of these discoveries is given by D. F. Kidd, of the Geological Survey of Canada. The author says that for the past two seasons prospecting has been actively carried on along the east shore of Great Bear Lake and north-eastward to Coronation gulf on the Arctic ocean. Discoveries of pitchblende (radium bearing), silver, and copper have been made and have attracted considerable attention. The writer spent two months in this area in 1931 making a geological survey of the district for the Department of Mines, Ottawa, and the following notes are extracted from his article.

General Features.—Great Bear Lake lies on the Arctic circle east of the Mackenzie River. The Great Bear River about 90 miles long drains it. The immediate shores of the lake are rather low and regular, and are mostly covered with drift, except along the east side where the shore is rugged, with rocky hills which rise in places over a thousand feet above the lake. The shoreline here also is highly indented and there is in places a fringe of islands. This rugged country extends for at least 50 miles east of the lake. The relief becomes somewhat less to the north and in the vicinity of the Dismal lakes, west of the Coppermine River and north of Great Bear Lake, the irregular topography is replaced by regular scarped hills running west and north-west.

Timber is found in all the area south of the Dismal lakes, but with the exception of groves in the more sheltered valleys it is nowhere of much size. Sufficient is present at Labine Point and Hunter Bay for cabin construction and for initial mining operations. Game is not plentiful, but various fish are abundant in Great Bear Lake. Flies are bad, especially away from the lake.

The season of open water is short. The ice leaves the heads of the bays in June, but large fields remain in the main body of the lake throughout July. Last season aircraft on floats landed on the lake in the last week in June, but the first motor-boat from the outlet only reached the east side on July 20, and this was a record trip. Frosts can be expected after the middle of August, and aircraft on floats have to leave early in September. Navigation on the lake, though difficult, is possible till the end of the same month. The summer is calm, clear, and cool on the lake, but on the Arctic slope north of the height of land the summer weather appears to be much more severe.

General Geology.—The rocks of the area have been temporarily grouped into three main divisions pending further geological work:—

Flat lying sandstones and conglomerates.

Intrusive granitic rocks.

Folded sedimentary and volcanic rocks. They are probably all Precambrian.

A variety of rocks showing great differences of metamorphism have been grouped. It is entirely possible that they belong to two or perhaps more major series of rocks, but so far no attempt has been made to separate them. They comprise tuffs, conglomerates, sandstones and quartzites, agglomerates, some flows, banded sediments (in part probably of volcanic origin), cherts, lean iron formation, limestone, and dolomite. For the area so far explored they are listed approximately in order of abundance. Intruding into these rocks are granites, grading into granodiorites near the borders of the masses. Granite pebbles in some of the folded conglomerates show there is, or was, older granite in the vicinity, but it has not yet been recognized. The youngest consolidated rocks are a series of flat-lying sandstones and conglomerates, shown on the map in the vicinity of Hornby Bay. One hundred miles to the north there is the Coppermine River Series of gently dipping sandstones and conglomerates and basaltic flows. The Hornby Bay rocks may possibly be correlated with these, but may be of different age.

Cutting all these rocks are basic dykes and sills, and large quartz veins. The dykes and sills are up to 200 ft. wide and are in various attitudes. They are numerous, and only some of the most persistent are shown on the map. A system of large quartz vein cuts all the rocks of the area except the basic dykes, with which their relations are unknown. These veins are found at intervals from Labine Point north to Hunter Bay and then north-east for at least 25 miles. In some places several veins are present in a width of 1 to 2 miles across their strike. They are in places over 500 ft. wide though more often 50 to 300 ft. Individual veins have been traced for as far as three miles. They enclose fragments of the rocks they intrude and have altered them. The quartz in them is of more than one age, and in places they contain some specular hematite.

Mineral Deposits.—(*a*) *Copper.*—Two main types of mineral deposits have been found in the area: (*a*) copper deposits, (*b*) pitchblende deposits with silver, and silver deposits. Three copper deposits have been found at Hunter Bay, and another 100 miles in a northerly direction, north of the Dismal lakes and west of the Coppermine River. Other discoveries, apparently of less importance, have been made in the Dismal lakes district. Two of the three deposits at Hunter Bay were examined. They are near the borders of the large quartz veins mentioned above. The mineralization is of chalcopyrite, bornite, and chalcocite, in varying proportions, in bands in the vein. A little specular hematite and occasional specks of pyrite were found; but the copper minerals predominate. The mineral

sequence is pyrite, chalcopyrite, bornite, and chalcocite and there is minor secondary covellite.

At the Consolidated Mining and Smelting Company's property, four miles north of Hunter Bay, preliminary trenching has been done along a mineralized band in one of the quartz veins. The vein cuts granite, and with its bordering stockworks has an exposed width of 800 ft. The mineralization is disseminated chalcocite and bornite with subordinate chalcopyrite. The band has been traced in pits for 420 ft. In one pit there is 35 ft. of quite abundantly disseminated chalcocite and bornite in quartz, but in the end pits of this 420 ft. there is little mineralization. Insufficient work has yet been done to permit any estimate being made of quantity of mineralization.

Two miles south of Hunter Bay on the shore of Great Bear Lake, Dominion Explorers, Ltd., have traced a train of bornite bearing quartz boulders to a quartz vein 100 ft. wide extending into the lake. Near the shore trenches and outcrops showed a band near the east side of the vein carrying chalcopyrite and bornite in a matrix of quartz and altered country rock. This band was traced for 150 ft., disappearing under drift at the lake end. Diamond drilling has been undertaken to intersect the vein further south. Some trouble was experienced, but one hole intersected copper mineralization at a point under the lake 300 ft. south of the last trench. A third deposit at Hunter Bay, held by Eldorado Gold Mines, was not examined.

Twenty miles north of the Dismal lakes and 40 miles from Fort Hearne at the mouth of the Coppermine River, Northern Aerial Minerals Exploration are developing a deposit of bornite found in 1930. The deposit has been well described by Duncan. The bornite mineralization occurs in a vein with quartz and a buff carbonate mineral. The vein is steeply dipping; and cuts the gently dipping basaltic flows of the Coppermine River Series. It is easily traced in a narrow draw for 1,800 ft. The rock is much shattered and has scattered quartz and carbonate veinlets for 50 ft. on one side of the vein proper. The mineralogy of the deposit and certain peculiar features of the quartz suggest that it be grouped with those found at Hunter Bay. Ten trenches had been dug before the spring thaw in 1931, but all had partially caved. In the summer, one pit showed 11½ ft. of nearly solid bornite with a little chalcopyrite in places. Only one edge of the bornite is exposed. Another pit 40 ft. south shows 4 ft. of bornite and both edges. A pit 40 ft. further south has 18 in. of bornite and only one edge exposed. It is reported that before the pits caved a lens of massive bornite with a maximum width of 15 ft. was found, and that in some of the adjoining pits two bands of bornite were found in the vein, possibly indicating the presence of other lenses.

(*b*) *Silver and Pitchblende.*—The pitchblende and silver deposits are present in an area centring round Echo Bay, on the shore of Great Bear Lake 35 miles south of Hunter Bay. Echo Bay has steep rocky shores, and several narrow arms extend 15 or more miles east of the main body of the lake. Labine Point is the north point of the mouth of the bay, and Sixty-six Point, six miles to the south, is the south point. On the properties of Eldorado Gold Mines on both these points silver discoveries have been made, and on Labine Point pitchblende is present with the silver. Silver has also been found one and a quarter miles north-east of Labine Point on claims of Consolidated Mining and Smelting Company.

The rocks at Labine Point are banded altered sediments and volcanics. Granite is found on the tips of small points, and on offlying islets along the west side of Labine Point and as far north as the main granite mass shown on the map. At Labine Point the rocks have been so metamorphosed by the adjacent granite that their original characters are almost unrecognizable. Over most of the point the rock is hard, fine-grained, and irregularly pink and greenish gray in colour with bedding only occasionally visible. . In addition to the general metamorphism there are local areas of intense metamorphism with magnetite, coarse black biotite, actinolite, and tremolite developed and areas of pyritization that show on the surface as large gossans. Magnetite is particularly abundant and widespread.

These rocks are cut on the point by zones of fracturing and shearing, striking somewhat north of east and converging in that direction; and also by a considerable number of small quartz and calcite veins striking a little east of north and in other directions. The shear zones have been the loci of repeated mineralization. On three of the zones on the point development work has been done.

The mineralogy of the first and third zones is similar. The shattered rock has been intruded by quartz, forming vein breccias and stockworks up to 30 ft. wide. Pitchblende occurs along the hanging wall and is a very early formed mineral. Chalcopyrite, clearly replacing much earlier pyrite, is also early. The chalcopyrite is veined by quartz. The last stage of mineralization consisted of a gray cobalt mineral (cobaltite ?), comb quartz, chalcopyrite, specular hematite, and an iron bearing carbonate perhaps ankerite. Cobalt bloom, and alteration products of pitchblende are present.

In the second or middle zone the rock is extensively fractured, but the quantity of introduced quartz is less, so vein breccias are not prominent. In places carbonate minerals are abundant. There is a brownish red manganese bearing carbonate, a brownish yellow iron bearing carbonate, and dark brown siderite. The carbonates are more abundant in the northern part of this zone. The mineralogy is more complicated, including magnetite, actinolite, biotite, fluorite (?), pitchblende, pyrite, chalcopyrite, galena, tetrahedrite, bornite, native silver, covellite, native bismuth, and the surface alteration products, malachite, azurite, gummite and other pitchblende alteration products, manganese oxides, cobalt bloom, and occasional specks of native copper. In the southern part of the zone the pitchblende is brecciated and cemented by quartz forming a micro breccia. In the northern part the pitchblende is massive with botryoidal and mamillary surfaces, and there is little quartz in it. Preliminary microscopic study shows pyrite, chalcopyrite, galena, tetrahedrite, silver, and covellite in radial fractures in this pitchblende. Chalcopyrite replaces pyrite, and covellite replaces chalcopyrite. Galena and tetrahedrite are near the same age and are later than chalcopyrite. The relations of the silver have not yet been determined except that it is a late mineral in the deposit. The late mineralization stage of cobalt minerals, native bismuth, chalcopyrite, quartz and carbonates is present, but is not as prominent as in the other zones.

At the north end of the No. 2 zone abundant native silver has been found along the west or hanging wall side of the zone of shearing which here dips steeply west, and has a minor change in strike.

The silver is present filling tiny cracks in country rock, disseminated as almost invisible wires, and as larger plates and leaves. Because of its frequent very fine grain any estimation of silver values is difficult. Grab samples and selected channel samples showing very high values can be taken, but no real idea of the grade can be obtained without close, regular channel sampling. In its absence any estimates made below must be regarded as a guess. Silver has been found in five pits in a length of 180 ft. Some of it is exceptionally rich material. The mineralization is not terminated in the northernmost trench. A pond, possibly indicating more fractured conditions, prevents further trenching to the north.

Visible silver in areas of a few square feet has also been found at two places in the next 600 ft. south in the zone. Small amounts of silver are present in several small veins at other places on the point. None was seen in the No. 1 or No. 3 zones.

Pitchblende is found in all three explored shear zones at Labine Point and is said to be present in a fourth zone not examined. It is reported in a showing 2 miles to the north, and also in one 6 miles south-east. In the No. 1 zone a lens showing 11 in. of pitchblende is said to be present in the bottom of a water filled pit at the lakeshore. Three hundred and fifty feet to the north there is an exposure showing a lense of pitchblende 6 in. wide. Much of the intervening vein is under the lake. In the No. 2 zone pitchblende has been found as several seams $\frac{1}{8}$ in. to 1 in. thick of rich material, plus 50% uranium oxide (130 mg. radium per ton), in a width of a foot or less, and as lenses up to 20 in. wide of brecciated pitchblende with 10–20% uranium oxide (26–52 mg. radium per ton). The lenses do not usually maintain widths of over one foot for lengths of more than 10 ft. The narrow seams have been found in 13 out of 14 pits sunk in a length of 1,300 ft. along the zone.

In the No. 3 zone a lens 9 in. wide of moderate grade pitchblende was found in one pit, and in a second pit 40 ft. to the south a persistent $\frac{1}{2}$ in. seam of rich pitchblende is present. A third pit to the north shows no pitchblende.

One and one-quarter miles north-east of Labine Point, along the strike of the shear zones on the point, two shear zones have been discovered in a band of altered sedimentary rocks. Test pits have been sunk by Consolidated Mining and Smelting Company. One zone showed disseminated chalcopyrite and galena over a width of several feet in some pits. A second zone 300 ft. east showed a seam 1 to 12 in. wide carrying a cobalt mineral, cobalt bloom, and in places rich native silver. In the adjoining rock are abundant manganese oxides and some chalcopyrite and galena. This seam has been traced in pits for 400 ft.

Six miles south of Labine Point at Sixty-Six Point two discoveries had been made on claims of Eldorado Gold Mines, at the time of the writer's visit, but no development had been done on either. The point is bisected from east to west by the contact of granite with older rocks to the north. At the eastern discovery, two miles from the end of the point and about 300 ft. from the contact, a shear zone more or less paralleling it has been traced for 300 ft. with a possible extension of 400 ft. more. It lies in siliceous volcanic agglomerates and flows. In this zone of shearing some calcite is present, and in a few spots native silver and sparsely scattered bornite, chalcopyrite, galena, and cobalt bloom.

One half mile nearer the end of the point a zone of fracturing in fine-grained hematitic rocks can be traced for 300 ft. along the north side of a shallow depression, disappearing under a small lake at the west end. Across the depression is a small area of banded rocks but elsewhere in the immediate vicinity is biotite granite. The zone of fractured rock is up to 30 ft. wide. Some fractures are filled with light green to brown carbonate. At three places in the first hundred feet of the zone back from the shore of the small lake, native silver was found sticking out of the weathered surface. It is present as wires in the carbonate and in the hematite rock. At one place over an uncovered area 3 ft. in diameter it was abundant. No work had been done and continuity of the silver between the exposures was not shown. It is said that later development work has improved this showing.

The silver deposits described have been found in shear zones near granite contacts. At Labine Point they are near a basic sill. This sill is subsequent to the shearing and introduction of quartz, but as the silver is a late mineral in the shear zones the sill or its parent rock cannot yet be eliminated with certainty as a possible source of the silver mineralization. The association of silver with pitchblende and copper, lead, and manganese minerals is new in Canada.

Mining Gold-Silver Ore at Jarbidge, Nevada.—The mining of gold-silver ore at the Elkoro mines at Jarbidge, Nevada, is described in Information Circular 6,543 of the United States Bureau of Mines, by J. F. Park. This is the principal operation at Jarbidge, Nevada, a remote district, which is nevertheless one of the principal gold producing centres of the State. The gold and silver occur in quartz veins dipping steeply into a thick series of Tertiary lava flows. Prospecting and exploration are rendered difficult by a covering of surface wash over much of the area and by the extensive faulting of the rhyolite flows, only a relatively small vertical section of which appears to have been favoured with ore-deposits of economic importance. Mining conditions are favourable, as the ground stands well enough to permit of shrinking stoping, and the rugged topography of the country has favoured the development of the ore zone by adits. In the year 1930, for which costs are given, all the production was from shrinkage stopes, although cut-and-fill methods have been used in the past and will be used again in areas where cross-faulting has weakened the vein walls. A drainage problem connected with the recent development of an ore-body lying below the bottom adit was solved by the installation of a deep well-type centrifugal pumping plant.

Ore is transported by hand or mule tramming on some of the stoping levels, and by electric locomotive haulage on two main levels. The lower of these levels is at the elevation of the mill. From the adit of the upper level the ore is transported 1,200 ft. to the mill by aerial ropeway.

Mining costs, excluding development, are given in considerable detail, and amount to $2·61 per ton. Development costs are $11·33 per ft. for driving, $10·30 for rising, and $23·82 for winzes. The cost of aerial ropeway transport is given as 13½ cents per ton. The problem of bringing in supplies from the railway at Rogerson, Idaho, has been chiefly one of road making. Improvement in the road has gradually reduced the cost of this service from 2 cents to slightly less than 1 cent per lb. for the 70-mile truck haul.

SHORT NOTICES

Rising.—M. J. Elsing deals with the cost of rising in the *Engineering and Mining Journal* for February.

Sharpening Drill-Steel.—The equipment of the drill shop of the Randfontein Estates is described by A. Leyland in the *Engineering and Mining Journal* for February.

Sillimanite.—The mining, treatment, and uses of the sillimanite group minerals are dealt with by F. H. Riddle in Technical Publication No. 460 of the American Institute of Mining and Metallurgical Engineers.

Flotation.—In the *Bulletin* of the Institution of Mining and Metallurgy for February, K. E. Armytage deals with some operating details of flotation practice.

Contact Angles in Flotation.—I. W. Wark and A. B. Cox give the results of an experimental study of the effect of xanthates on contact angles at mineral surfaces in Technical Publication No. 461 of the American Institute of Mining and Metallurgical Engineers.

Union Minière Leaching Operations.—In Technical Publication No. 459 of the American Institute of Mining and Metallurgical Engineers, A. E. Wheeler and H. Y. Eagle deal with the development of the leach operations of the Union Minière du Haut Katanga.

Sintering.—The sintering of zinc ore at Rosita, Mexico, is described by H. R. MacMichael in Technical Publication No. 455 of the American Institute of Mining and Metallurgical Engineers.

Reverberatory Smelting Raw Concentrates.—P. D. I. Honeyman describes the reverberatory smelting of raw concentrates at the International Smelter, Miami, Arizona, in Technical Publication No. 456 of the American Institute of Mining and Metallurgical Engineers.

Copper-Refining Furnace Fuels.—In Technical Publication No. 457 of the American Institute of Mining and Metallurgical Engineers, E. S. Bardwell makes a comparison of the use of various fuels in copper-refining furnaces.

Messina Converter.— R. G. Knickerbocker, in Technical Publication No. 458 of the American Institute of Mining and Metallurgical Engineers, describes the Messina stationary basic copper converter.

Sintering Economics.—Technical Publication No. 480 of the American Institute of Mining and Metallurgical Engineers, by P. G. Harrison, is called sintering economics.

Electrical Coring.—A method of determining bottom-hole data by electrical measurements is described by C. and M. Schlumberger and E. G. Leonardon in Technical Publication No. 462 of the American Institute of Mining and Metallurgical Engineers.

Resistivity Surveys.—M. King Hubbert gives the results of earth resistivity survey on various geological structures in Illinois in Technical Publication No. 463 of the American Institute of Mining and Metallurgical Engineers.

Pipe-Line Corrosion Location by Electrical Measurements.—In Technical Publication No. 476 of the American Institute of Mining and Metallurgical Engineers, C. and M. Schlumberger and E. G. Leonardon describe the location and study of pipe-line corrosion by surface electrical measurements.

Resistivity Measurements.—G. F. Tagg deals with the interpretation of resistivity measurements in Technical Publication No. 477 of the American Institute of Mining and Metallurgical Engineers.

Gold Prospecting.—Prospecting for gold in the Shield Areas of Canada, Siberia, Southern Rhodesia, and Western Australia is discussed by W. H. Emmons in Technical Publication No. 452 of the American Institute of Mining and Metallurgical Engineers.

Tin Mining in Cornwall.—E. R. Lilley deals with the geology and economics of tin mining in Cornwall in Technical Publication No. 479 of the American Institute of Mining and Metallurgical Engineers.

Placer Gold in Equatoria.—J. L. Middleton describes placer mining for gold in French Equatorial Africa in the *Engineering and Mining Journal* for February.

European Kaolin.—In Technical Publication No. 475 of the American Institute of Mining and Metallurgical Engineers, E. R. Lilley describes the geology of some kaolins of Western Europe.

Granada Gold Mine.—B. Robinson describes operations at the Granada gold mine, Quebec, in the *Canadian Mining Journal* for February.

A Transvaal Colliery.—Equipment at the new Betty shaft of Vereeniging Estates, Ltd., is described in the *Colliery Guardian* for January 29.

Empire Mineral Resources.—A review of Imperial mineral resources by Charles Camsell appears in the *Canadian Mining and Metallurgical Bulletin* for February.

RECENT PATENTS PUBLISHED

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

19,120 of 1930 (364,085). A. B. Broughton-Edge, London. Apparatus and method for the determination of the nature of the sub-soil, which comprise means for instantaneously comparing phase and potential differences in respect of the currents flowing between any two pairs of three points in the region of exploration.

27,023 of 1930 (365,052). Copper Deoxidation Corporation, New York. Copper is electrolytically deposited in a coarsely crystalline and brittle form on a suitably-coated cathode.

29,528 of 1930 (364,567). Merco Centrifugal Separator Co., Ltd., San Francisco. A system for concentrating or thickening ore-pulps and slimes.

30,187 of 1930 (365,148). P. T. Williams and Minerals Separation, Ltd., London. Continuous dewatering apparatus of the type in which a filter cake is progressively formed at one portion of a filtering medium and progressively removed at another portion.

30,781 of 1930 (364,699). Gutehoffnungshutte Oberhausen A.-G., Oberhausen. Spongy iron is produced in an improved manner on a travelling grate, which is pervious to gas.

986 of 1931 (364,351). R. F. Bacon, New York. Preheated air used in the roasting of sulphide ores is found to enrich the roaster gases in sulphur dioxide, which is subsequently reduced to elemental sulphur.

1,066 of 1931 (365,312). International Precipitation Co., Los Angeles. Suspended material in gases is removed by centrifugal action.

4,204 of 1931 (364,890). Fried. Krupp Grusonwerk A.-G., Magdeburg-Buckau, Germany. A differential flotation process for the working-up of cryolite.

29,157 of 1931 (365,097). Humboldt-Deutzmotoren A.-G., Köln-Kalk, Germany. Improvements in the froth flotation of cryolite.

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.

Flotation. By A. M. Gaudin. Cloth, octavo, 552 pages, illustrated. Price 36s. London: McGraw-Hill.

A Key to Mineral Groups, Species, and Varieties. By Dr. Edward S. Simpson. Cloth, octavo, 84 pages. Price 10s. 6d. London: Chapman and Hall.

Lubricating Oil Tests and their Significance. By J. E. Southcombe. Paper boards, 69 pages, illustrated. Price 2s. 6d. London: Henry Wells Oil Co.

A History of Fire and Flame. By Oliver C. de C. Ellis. Cloth, octavo, 436 pages, illustrated. Price 15s. London: Simpkin, Marshall, Ltd.

Beiträge zur Geschichte des österreichischen Eisenwesens. Abt. 1, Heft 1, pages 1-165. Die Geologie der innerösterreichischen Eisenerzlagerstätten. By Dr. K. A. Redlich. Paper covers, illustrated, with map. Price RM 14.40. Abt. 1, Heft 2, pages 169-226. Norisches Eisen. By Dr. Walter Schmid. Paper covers, illustrated. Price RM 5.40. Abt. II, Heft 1, pages 1-192. Eisenverarbeitung und Eisenhandel. By Dr. Kurt Kaser. Paper covers, illustrated. Price RM 10.80. Berlin: Julius Springer.

Über die Ausbreitung der von Grosskolbenmaschinen erzeugten Bodenschwingungen in die Tiefe. By Dr. Ing. G. Bornitz. Paper covers, 44 pages, illustrated, with plans. Price RM 15. Berlin: Julius Springer.

Geophysical Prospecting, 1932. Cloth, octavo, 510 pages, illustrated. Price $5·00. New York: American Institute of Mining and Metallurgical Engineers.

Studies of Geophysical Methods. Canadian Geological Survey Memoir 165. Paper covers, 227 pages, illustrated, with charts. Price 45 cents. Ottawa: Department of Mines.

Canadian Geological Survey Summary Report, 1930, Parts A, B, and C. Paper covers, illustrated. Ottawa: Department of Mines.

Bibliography of North American Geology, 1929 and 1930. United States Geological Survey Bulletin 834. Paper covers, 280 pages. Price 45 cents. Washington: Superintendent of Documents.

Quakertown-Doyleston District, Pennsylvania and New Jersey. Geology and Mineral Resources. United States Geological Survey Bulletin 828. By F. Bascom, E. T. Wherry, G. W. Stose, and A. I. Jonas. Paper covers, 62 pages, illustrated, with map. Price 40 cents. Washington: Superintendent of Documents.

The Kaiparowits Region: A Geographical and Geological Reconnaissance of Parts of Utah and Arizona. United States Geological Survey Professional Paper 164. By H. E. Gregory and R. C. Moore. Paper covers, 161 pages, illustrated, with map. Price $1·05. Washington: Superintendent of Documents.

United States Geological Survey: Shorter Contributions to General Geology, 1930. Professional Paper 165. Paper covers, 180 pages, illustrated, with map. Price $1·25. Washington: Superintendent of Documents.

Green River Formation of Colorado and Utah: Origin and Microfossils of the Oil Shale. United States Geological Survey Professional Paper 168. By W. H. Bradley. Paper covers, 58 pages, illustrated. Price 60 cents. Washington: Superintendent of Documents.

California: Mineral Production, 1930. Division of Mines Bulletin No. 105. Paper covers, 231 pages, illustrated. Bulletin No. 106. Manner of locating and holding Mineral Claims (with forms). By A. H. Ricketts. Paper covers, 20 pages. San Francisco: Division of Mines.

Alaska: U.S. Geological Survey Bulletin 824, Part C, The Lake Clark-Mulchatna Region. By S. R. Capps. Paper covers. Price 10 cents. Part D, Mining in the Circle District. By J. B. Mertie, Jun. Paper covers. Price 5 cents. Part E, Occurrence of Gypsum at Ivonkeen Cove, Chicagof Island. By B. D. Stewart. Paper covers. Price 5 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1930. Part I, pp. 179-207, Tungsten, by F. L. Hess; pp. 133-150, Vanadium, Uranium, and Radium, by F. L. Hess; pp. 151-178, Bauxite and Aluminium, by C. E. Julihn; pp. 243-266, Chromite, by Lewis A. Smith; pp. 333-354, Secondary Metals, by J. P. Dunlop. Part II, pp. 181-203, Magnesium and its Compounds, by P. M. Tyler; pp. 205-246, Asphalt and Related Bitumens, by A. H. Redfield; pp. 277-290, Slate, by O. Bowles and A. T. Coons.

Kingston's Sterling Fluctuation Tables—as measured in currencies on a gold standard. Paper card. Price 1s. London: Kingston's Translations Institute.

The Empire's Future Goldfield—A Second Rand—Gold Coast and Ashanti. By G. A. Stockfeld. Paper covers, 16 pages, illustrated. Price 6d. London: Whitehead Morris.

DIVIDENDS DECLARED

Amalgamated Zinc.—2½%, less tax, payable April 9.

Champion Reef.—1s. 6d., less tax, payable March 19.

Kramat Pulai.—6d., less tax, payable March 18.

Malayan Tin.—1½d., less tax, payable March 17.

Mysore Gold.—1s., less tax, payable April 2.

North Broken Hill.—1s. 6d., less tax, payable March 23.

Nundydroog.—2s. 3d., less tax, payable April 5.

Oroville Dredging.—9d., less tax.

Petaling Tin.—7½%, less tax, payable March 1.

Pato Mines (Colombia).—20s., less tax, payable March 14.

Rawang Concessions.—6d., less tax, payable March 22.

St. John del Rey.—Pref., 1s., tax free; Ord., 1s. 3d., less tax, payable April 29.

Tronoh.—1½d., less tax, payable April 5.

Village Deep.—1s. (return of capital), payable July.

Witbank Colliery.—9d., less tax, payable April 1.