The Mining Magazine

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CONTENTS

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Rand Low Grade Ore Commission

In referring to the expectation of life of the Witwatersrand goldfield, we have in the past had occasion to consider the definition of the word " ore." Under the present conditions of administration on the Rand what is unavoidably fixed as ore—that portion of the mineral deposit which can be mined at a profit—enables most of the companies operating to pay dividends, in some cases of quite a substantial character. A superficial examination of the facts has, therefore, called forth the comment that as long as they can earn such profits the companies concerned have really little to complain about. For a true estimation of the position, however, it is necessary to go deeper and to assume, as the companies claim, that it is not the size of their profits about which they are concerned, but the life of the mines. In other words, it can be assumed that if such legislation were enacted on the Rand as would enable the mines to extract ore of lower grade the companies would be prepared to mine such ore and thereby give their properties a longer life. Such, at any rate, is the unanimous opinion of the Low Grade Ore Commission recently set up in South Africa, whose report has just reached this country. In the words of the report, " a reduction of 2s. per ton milled in working costs and yield will probably result in an increase of at least 50% in the future average life of the Witwatersrand." It is obvious, therefore, that the commission considers it advisable that the mines should be in a position to mine ore of lower grade and the *raison d'etre* of this important body appears to have been justified.

The examination of the vast mass of evidence presented to the commission has enabled it to prepare a number of recommendations for the consideration of the Union Government, all of which may be regarded as being for the assistance of the industry. It is important to note here, too, that the conclusion has been reached that the mines are managed efficiently and that they cannot mine any more unpayable ore than they at present do without some economic aid. Turning to the main findings of the commissioners, it is stated that after having heard a certain amount of evidence they were so impressed by the necessity of securing a permanently adequate supply of native labour for the mines that they thereafter confined their attention almost entirely to that subject and were thus enabled to issue an interim report in March, 1931, dealing with this matter. Under certain conditions, it was suggested that permission be granted to recruit natives north of latitude 22° south, while the opening of certain areas at present closed to recruiting was also recommended. The purchase of coal and supplies, it is considered, are managed so efficiently as to preclude the possibility of any savings in this direction which might help the low-grade properties, although a revision of the terms of the contract for the supply of power by the Victoria Falls company is suggested. In regard to miner's phthisis compensation, the majority of the commissioners are of the opinion that it is unjust to expect the scheduled mines to shoulder the phthisis payment of mines no longer in existence and some State help in this matter is recommended. Certain suggestions put before the commission for the reorganization of labour underground have been previously examined in these columns, particularly those put forward by Dr. Pirow, which aim at lessening the exposure of whites to the conditions that produce phthisis. The commission agrees that the present position as regards the imminence of phthisis cases is unsatisfactory, but the financial responsibility laid on the companies is considered too heavy, although it is recognized that this responsibility is essential in order to bring about an improvement in working conditions. To the casual observer it might appear that the substitution of native for white labour on certain underground operations was simply an evasion of responsibility, although the commission is of the opinion that such a substitution might be effected without detriment to the safety and health of the natives. The commission also has something to say on the question of railway rates, which are considered in many cases to be too high, and the setting up of a new commission to examine the whole railway policy of the Union is recommended.

In reviewing the findings of the commission, it is evident something more will be necessary to enable mines working at a loss to be profitably operated. It would seem that such mines can only continue with the help of a subsidy from the Government, either in cash or by remission of taxation, or by a revision of wages. In this connexion,

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it is interesting to note a division of opinion on the wages question in the commission's findings. Certain members were of the opinion that the present level of wages on the Rand was too high, although it is difficult to follow this view where mines are operating at substantial profits. The all-round reduction of 10% suggested by some members seems inequitable, although it must be recognized that mines working at a loss or just making ends meet might well be justified in lowering wages. At any rate, the Union Government, if it decides to adopt any of the commission's findings, and so enable the mines to work lower-grade ore, must be prepared to subsidize the industry or to permit a revision of wages, always providing, of course, that it does not find the simpler way to be that of allowing the Union currency to follow sterling off the gold standard.

The Royal School of Mines Dinner

The 55th annual dinner of the Royal School of Mines, under the auspices of the Old Students' Association took place on June 16, Mr. G. W. Gray, this year's president, being in the chair. It was essentially a family gathering, as on many previous occasions, and among the guests there were really no strange faces, with the solitary exception of Mr. Roxburgh, the Headmaster of Stowe School, whose presence was especially welcome as continuing a practice of entertaining the Head of one or more of the public schools. The other guests, as has been indicated, require no introduction, including Mr. Chester Beatty, Mr. Carl Davis, and Mr. James Kewley.

The task of proposing the toast of the Royal School of Mines fell to Mr. Kewley, the president of the Institution of Petroleum Technologists, who delivered just the kind of inspiring and complimentary speech that is expected on these occasions. After alluding to the great antiquity of the professions of mining and metallurgy, he went on to consider their dignity and had occasion to refer to the writings of Agricola. After-dinner speakers at functions of this character would seem to be sorely handicapped had they no De Re Metallica to turn to for inspiration, if not actual quotation. Mr. Kewley paid tribute to the early geological workers in this country, whose activities led to the inception of the Royal School of Mines. Referring to the period when petroleum technology was first taught there, he remarked on the remarkable growth of the industry with which he is himself so closely associated. Returning to the safe harbour of Agricola, he extracted more wisdom concerning the personnel engaged in the profession, and expressed regret at the absence of the pioneering spirit in many of the young men of to-day, although he hoped this was not true of Mines men. The chairman, in responding, thought that mining men as a whole were not unlike moles, who, accustomed as they were to living underground, were apt, when they come to the surface, to blink and behave rather like fish out of water. To Professor Truscott he paid a well-deserved tribute, not only in his capacity as honorary secretary of the association—as the speaker remarked, Professor Truscott is the association—but also as the teacher of mining at the School. This naturally led to a eulogy of the training that is afforded and an appreciation of the high standard to which the Imperial College has attained. Mr. Gray rightly emphasized in this connexion a quality which he was pleased to call—as, indeed, it is commonly called—"guts" and he spoke with warm approval of a training which gave the students scholarship accompanied by a certain prowess in the world of sport. A combination of this character is, as the speaker remarked, the finest qualification for British mining engineers, who in these days have to meet with healthy competition from the Colonies and the United States. In this connexion reference was also made at some length to the international character of the profession of mining engineering and Mr. Gray said he preferred to regard it not so much as a matter of competition between countries in producing the most efficient operators but rather the reverse, a friendly spirit being much in evidence between British, Canadian, American, and other nationalities so engaged.

The toast of the guests was proposed by Mr. A. J. Bensusan—who enumerated their respective distinctions—and was responded to by Mr. Roxburgh. That, rather, was the programme, but as the latter had to leave early he was placed in the unique position of responding to a speech that had not been delivered, certainly an innovation at these dinners. Mr. Chester Beatty also responded for the guests and felt that he must make some reference to present

conditions in world trade. If, he said, one considered the remarkable advances which had been made in mining practice and in the design of treatment plants, one could only regret that no similar advance had been made in the practice of politics and banking. As to the future, however, he was optimistic, as he was disposed to consider the present situation as but 25% economic, the other 75% being psychological, and he expressed the opinion that the world was past the worst—a cheery note which well suited the occasion. The proceedings concluded with Professor Cullis proposing the health of the chairman, who in turn called for a toast of the professors of the Royal School of Mines and the Royal College of Science, to which Professor Truscott replied.

The Geological Survey's New Headquarters

The report of the Geological Survey just issued[1] enables the public and more particularly the practical geologist to judge just what use is to be made of the fine building now approaching completion in Exhibition Road, South Kensington. To the admirable choice of the site for the new Museum of Practical Geology we have had occasion to refer previously and it is evident that the completed museum will not detract from the architectural beauty of this museo-collegiate part of London. Sir John Flett, director of the Survey, in his summary of activities during 1931, naturally devotes considerable attention to the building and its equipment and although, as he says, it has not yet been possible definitely to allocate space in the new Museum the main lines to be followed have been decided upon, leaving the details to be filled in at a later stage. It has evidently been settled that the exhibits in their new home will not be arranged in the same way as at Jermyn Street and a large amount of new material is to be incorporated, while a campaign of photography recently put in hand is calculated to permit of the ample illustration of the scenery typical of British geological provinces and the special character of their rocks. In addition past geological epochs are to be illustrated by coloured panoramic views and paintings, while scale models of interesting geological structures are also being prepared. During the present season active field work, carried out under the supervision of officers of the Survey, will, it is hoped, provide the specimens needed for new exhibits. It will readily be recognized that the task of arranging for the removal of the present collections to their new home will involve a tremendous amount of real hard work however well it may be organized, although the prospect of leaving the gloomy halls of Jermyn Street for bright Exhibition Road should promise a sufficient reward.

A museum supported by the State is obliged, naturally, to provide a certain amount of popular display, although it is to be hoped that in the present case the liaison between the Survey and the authorities at the Natural History Museum in Cromwell Road will be sufficiently close to prevent the duplication of elementary exhibits. Material illustrating the general principles of geology and a few of its interesting applications will occupy the main floor, while the first gallery will represent the regional geology of Great Britain. For this purpose the country has been divided into 16 districts, each allocated to an experienced officer, and each division of the gallery will be illustrated by rocks, fossils, maps, diagrams, models, and photographs, while it is intended to issue an illustrated handbook explanatory of the exhibits. The second gallery will illustrate the practical applications of geology and the industrial uses of rocks and minerals. So much for the general public. For the practical geologist one floor is reserved, the whole of the top floor of the Museum, having a superficial area of 16,000 square feet, being devoted to research and study collections. These are to be arranged in four series, palæontological, petrographical, mineralogical, and palæobotanical, each under the custody of a specialist. Access to this gallery will be free to geologists undertaking research and who wish to consult the survey collections. It is also probable that working accommodation for visiting specialists will be provided, so that it is hoped the new Museum may become a centre of research giving every facility for specialists to make use of the extensive collections which the Survey has built up during the past century. With so nice a balance of the popular and the practical as has been carefully arranged it is to be hoped the visiting public will be sufficiently impressed as to form some conception of the importance of the work of the Survey.

[1] Summary of Progess of the Geological Survey, 1931. Part I. Price 1s. 6d. London: H.M. Stationery Office.

REVIEW OF MINING

Introduction.—The most important happening during the past month has been the announcement of the Government's scheme for the conversion of the huge Five per Cent. War Loan, the rate of interest on the new Conversion Loan being 3½%. Industry should benefit considerably if the appeal now being made meets with the success anticipated. As regards metal prices, copper, after falling to new low records, shows signs of recovery, there being little change from last month's figures in other metals.

Transvaal.—The output of gold on the Rand for June was 913,297 oz. and in outside districts 45,714 oz., making a total of 959,011 oz., as compared with 965,644 oz. in May. The number of natives employed on the gold mines at the end of the month totalled 217,077, as compared with 215,926 at the end of May.

The accompanying table gives the dividends declared by the Rand gold mining companies on account of the past half-year. Figures for the preceding three half-years are given for comparison and from these it will be seen that there are two additions to the list, East Geduld appearing for the first time,

	2nd half, 1930.	1st half, 1931.	2nd half, 1931.	1st half, 1932.
	s. d.	s. d.	s. d.	s. d.
Brakpan	4 6	4 0	4 0	3 0
Consolidated Main Reef	1 3	1 3	1 3	1 3
Crown	3 6	3 6	3 6	3 6
Durban Roodepoort Deep	0 6	0 9	0 9	0 9
East Geduld	—	—	—	1 0
East Rand	—	—	0 6	0 3
Geduld	3 3	3 3	3 6	3 6
Geldenhuis Deep	1 0	1 0	1 0	1 0
Government Areas	2 3	2 3	2 3	2 3
Langlaagte Estate	2 0	2 0	2 0	2 0
Modderfontein B	2 0	1 6	1 6	1 3
Modderfontein Deep	3 3	3 0	3 0	2 9
Modderfontein East	2 0	2 0	2 0	2 0
New Modderfontein	6 6	6 0	5 6	5 3
New State Areas	2 0	2 0	2 0	2 0
Nourse Mines	0 9	0 9	0 9	0 9
Randfontein	—	—	0 6	0 9
Robinson Deep (A 1s.)	1 6	1 6	1 6	1 6
Robinson Deep (B)	7½	4½	0 6	0 6
Rose Deep	0 6	—	0 6	—
Springs Mines	4 0	3 9	4 0	3 9
Sub Nigel	3 0	3 0	3 6	4 0
Van Ryn	0 6	0 6	0 9	1 0*
Van Ryn Deep	3 0	2 6	2 6	2 0
West Rand	—	—	—	0 3
West Springs	1 0	0 9	0 9	0 9
Witwatersrand Gold	1 0	0 6	0 6	0 3

* Free of Tax.

while West Rand reappears. The Brakpan company in announcing a reduction of 5% to 15% in the half-year's dividend stated that it had been decided to pay the first instalment of £50,000 due to Witpoort Areas on June 30. With the exception of the Van Ryn payment, all dividends are declared in South African currency.

It was announced last month that the General Mining and Finance Corporation had exercised its option to subscribe at 10s. per share for the 270,576 ordinary shares of West Rand Consolidated Mines, Ltd., held in reserve.

Further development of the Far East Rand should follow the acceptance by the Union Government of tenders submitted by the Rand Mines, Consolidated Gold Fields, and the Anglo American Corporation for two areas on the Daggafontein, Grootfontein, and Vogelstruisbult farms, which brings one step nearer the formation of the two new companies announced at the annual meeting of the Central Mining and Investment Corporation. The first company is to be called the Vogelstruisbult Gold Mining Areas and particulars of its capitalization are still to be announced. In a statement issued by the Rand Selection Corporation, however, particulars of the second company are given. This will be known as the Daggafontein East and will have an initial capital of £350,000 in £1 shares, of which 100,000 have been allotted to Daggafontein Mines, Ltd., which will in return allow Daggafontein East the use of its No. 1 shaft and undertake preliminary development work in the new area. In addition to the ground acquired for the two new companies, the Sub Nigel was successful in its tender for 2,027 claims on the farm Grootfontein, which will increase that company's area to 6,583 claims, making it the largest on the Eastern Rand.

A circular to shareholders of Village Deep, Ltd., issued last month, stated that the reduction of capital to £425,048 0s. 6d. by the return of 1s. on each 9s. 6d. share, confirmed at an extraordinary meeting in May last, has now been sanctioned by the Supreme Court.

At an extraordinary meeting of Northern Platinum Exploration, Ltd., to be held in Johannesburg next month, it will be proposed that the company be placed in voluntary liquidation.

The report of Henderson's Transvaal Estates, Ltd., for the year to March 31 last shows a profit of £38,240, which, added to the balance of £18,351 brought in, gave an available total of £56,591. Of this amount £21,480 has been distributed as dividends, equal to 5%, £4,508 placed to reserve, and the balance of £30,603 is to be carried forward.

Southern Rhodesia.—The output of gold from Southern Rhodesia during May was

46,854 oz., as compared with 46,487 oz. for the previous month and 43,731 oz. for May, 1931. Other outputs for May last were: Silver, 7,843 oz.; coal, 41,783 tons; chrome ore, 1,927 tons; asbestos, 1,118 tons; mica, 5 tons; scheelite, 3½ tons.

At the annual meeting of the Cam and Motor Gold Mining Company it will be proposed that the capital of the company be reduced by the repayment of 7s. 6d. per share. In this way the assessment laid on shareholders on the reconstruction of the company will be returned.

The accounts of Falcon Mines, Ltd., for the year ended September 30, 1931, show a loss of £916, which increases the debit balance brought in to £175,667. It is stated that the Athens mine has been let on tribute, on terms satisfactory to the company

During the year 1931 Willoughby's Consolidated Co., Ltd., made a profit of £19,987, which, added to the balance of £2,425 brought in, gave an available total of £22,412. Of this amount £18,000 has been transferred to reserve, leaving £4,412 to be carried forward.

Northern Rhodesia.—The report of Mufulira Copper Mines, Ltd., for the year 1931 shows that the company's quota of copper is being produced by the Roan Antelope and N'Kana companies, while a portion of the Mufulira stock pile has been sold to the Rhokana Corporation. Since the last account the issued share capital of the company has been increased to £823,063 12s. by the issue of a further 3,230,629 shares to Rhodesian Selection Trust, Ltd., Rhokana Corporation, Ltd., and the British South Africa Co.

The report of the Luiri Gold Areas for May stated that the ore treated during the month had been drawn from the new ore-body above the second level. It is said that the third level in this body is higher in grade, but it is not yet sufficiently developed to supply the mill. Difficulties in following the old Dun Robin reef owing to faulting and water troubles on the 3rd level have decided the management to suspend milling and to concentrate on developing the Dun Robin ore-bodies and on opening up the Chibaba and Eclipse lodes.

At an extraordinary meeting of Rhodesian Selection Trust, Ltd., to be held this month it will be proposed that the capital of the company be increased to £2,500,000 by the creation of 5,000,000 new 5s. shares and that an agreement entered into with the debenture-holders (the American Metal Co., Ltd., Cull and Co., and the Lehman Corporation) be ratified. By the terms of this agreement the amount of outstanding debentures will be reduced, debenture interest up to March 1, 1937, will only be payable if profits are made, and the debenture-holders agree to subscribe for 404,000 shares.

Australia.—A dividend declared by the Broken Hill South company last month is, it is stated, to be paid out of profits derived from sources other than mining at Broken Hill. At present prices operations at the mines are being conducted at a loss.

It was reported last month that the Broken Hill Proprietary Company had decided to make an offer for the undertaking of the North Kalgurli (1912), Ltd. The latter company is to prepare an estimate of the value of its property and the offer is to be considered at the annual general meeting.

The report of South Kalgurli Consolidated, Ltd., for the year ended March 31 last shows a profit of £76,399, against £32,995 for the previous year, the effect of the gold premium having been favourable to the company. After adding the sum of £4,610 brought in, there is available a total credit of £81,009. Of this amount £31,251 has been distributed as dividends, £31,251 as a special bonus of 2s. 6d. per share, £12,000 written off property account, and £5,119 off new plant, the balance of £1,388 being carried forward. During the year 105,248 tons of ore was treated for a gross value of £255,473. The ore reserves at the end of the year were estimated to be 214,000 tons blocked out, averaging 8·45 dwt. per ton, and 94,700 tons of "probable" ore, averaging 6·09 dwt. At an extraordinary general meeting to be held following the general meeting this month it will be proposed that the capital of the company be reduced by the repayment of 2s. 6d. in cash on each share.

The monthly report of the Wiluna Gold Corporation for May states that, with a view to enlarging the scale of operations at the mine, the power plant is being extended by the installation of two further Diesel engines and alternator sets, which have been ordered. The excavation work for these units and for an addition to the thickening section of the plant is in hand.

The favourable developments reported at the Great Boulder Proprietary last month have been continued, work on the X-lode at the 1,800-ft. level confirming the developments at 1,650 ft. A horizontal hole on the

500-ft. level, 350 ft. south of the Edwards shaft, is stated to have struck a lode 17 ft. west of the level, 7 ft. wide, and of an average assay value of 18 dwt.

New Zealand.—The accounts of the Waihi Grand Junction Gold Company for 1931 show the amount received from the Waihi Gold Mining Company for the treatment of 26,496 tons of ore to have been £11,397, sundry other receipts amounting to £2,400. After making various allowances there remained a balance of £6,443, which, added to the £3,402 brought in, made an available total of £9,844, of which £6,906 has been distributed as dividends, equal to 4d. per share, leaving £2,938 to be carried forward. The ore reserves at the end of the year were estimated to be 23,126 tons, averaging 34s. 9d. per ton.

India.—Shareholders of Balaghât Gold Mines, Ltd., have been informed that on the conclusion of the agreement with Nundydroog Mines, Ltd., the process of handing over to the latter company is proceeding satisfactorily. At an extraordinary meeting this month special powers for the directors of the Balaghât company to deal with profits and to prepare for the voluntary liquidation of the company were approved.

Malaya.—The accounts of Malaysiam Tin, Ltd., for the year to March 31 last show a profit of £102. The output of tin concentrates under restriction regulations was 140½ tons, the present operations of the company being confined to low-grade ground. A circular accompanying the report states that in order to repay a bank loan, to provide working capital, and to provide a sum still owing to the vendors of the Glami property the company has created 18,000 7½% debentures, redeemable at 110 in 1947, of which £12,300 has been offered to shareholders.

At an extraordinary meeting of Anglo-Eastern Tin held last month it was approved that the capital of the company be increased to £60,000 by the creation of 100,000 new ordinary 2s. shares.

Bolivia.—During 1931 the operations of Fabulosa Mines Consolidated were conducted at a loss of £15,584, of which £14,317 corresponds to charges on the note issue, which it has been impossible to meet. During the year 597 tons of fine tin was produced, realizing £119 17s. per ton. Work on the Union group of mines has been suspended, operations being at present confined to the Milluni and Fabulosa sections.

Chile.—The report of the Poderosa Mining Company for 1931 shows a loss for the year of £41,545, increasing the debit balance brought in to £44,843. Mining operations ceased in May of the year under review, developments on the San Carlos lode being carried on up to the end of the year. The testing of the oxidized zones in the Grande mines, which was announced to shareholders in March last and which aims at determining the best method of extraction, is still proceeding.

Mexico.—Shareholders of the Santa Gertrudis Company have been informed that development work at the mine now fails to replace the ore extracted. In the circumstances any dividend payment is to be deferred until it has been determined what funds will be necessary for the testing or opening up of other properties in which the company is interested. Later advices have been received to the effect that an entirely new discovery has been made in the Elena South Cross-cut, where rich ore has been encountered.

Spain.—During 1931 the Peña Copper Mines, Ltd., made a profit of £13,084. After making various allowances and adding the credit balance brought in there was £28,413 available. Of this amount £10,000 was placed to reserve, the balance being carried forward.

British-Borneo Petroleum.—Elsewhere in this issue reference is made to a new property acquired by the British-Borneo Petroleum Syndicate in Germany. Shareholders of the company have now been informed that arrangements have been made with the Anglo-Persian Oil Co., Ltd., in order that the latter may participate jointly in the exploration of this concession.

Anglo-Oriental Mining Corporation.—The report of the Anglo-Oriental Mining Corporation for the year to February 29 last shows a profit of £23,553, the sum available for appropriation being £108,412. Of this amount £5,000 is transferred to reserve, the balance of £103,412 being carried forward.

Tin and Copper.—The scheme for the further restriction of tin production announced in the last issue of the MAGAZINE and generally known as the Byrne scheme has now been approved and came into force on the first of this month. As regards copper, the incidence of the new United States tariff has naturally involved the withdrawal of several important producers from Copper Exporters, Inc.

LAKE VIEW AND STAR GOLD MINES

By RALPH A. ANDERSON

A description of the procedure adopted on these properties with the object of increasing production and modernizing working methods

The Lake View and Star company operates two groups of gold mining leases aggregating 521 acres situated at Kalgoorlie, Western Australia. The western or more important group consists of leases formerly held by the Ivanhoe Gold Corporation, Ltd., Golden Horseshoe, Ltd., Chaffers Gold Mining Company, Ltd., Great Boulder Main Reef, Ltd., and Hannans Star, Ltd., whilst the eastern group consists of the original leases held by the Lake View Consols, Ltd.

The properties in the early days of the field were thus worked by six separate companies, but, with the passing of the years and with increasing depth and costs of production, output gradually dwindled, treatment plants became worn out and obsolete, prospecting and development ceased, and in 1928 it looked as though the end of the famous "Golden Mile" as a big producer was in sight, the operations of the mines being more or less abandoned to tributers. The population of the district dropped from over 30,000 in 1910 to 17,000 in 1928, property values fell away to nothing, and the whole district presented the appearance of neglect and decay so common to a mining camp when its heyday has passed.

In the middle of 1928, however, the Lake View and Star, Ltd., took over the control of the whole of the properties enumerated, giving the field a new lease of life by reason of the fact that the company decided upon a vigorous policy of development, the installation of a central treatment plant of the most advanced type, and the adoption of the best known principles as applied to mining. A steady increase in population has resulted and at the end of 1931 it stood at 19,000.

As a first move the company secured the services of a mining engineer of extensive experience to take over the position of general manager. After due consideration the conclusion was reached that an output of 30,000 tons per month by the end of 1932 was well within the capacity of the mines and that 40,000 tons per month might confidently be looked forward to a little later, provided prospecting for new lenses of ore and their development were pushed on. An extensive campaign of diamond drilling was initiated and it has resulted in the discovery of new lenses of pay ore throughout the properties in unworked portions from the upper levels to the deepest worked points. A schedule of development was laid down and the work is well in hand. It was confidently expected that the 30,000 ton mark would be reached in the May output of the present year.

At the outset it could be seen that the work of co-ordinating the work underground was beset with difficulties. The western leases had been worked from five main shafts, the manager of each mine had been a law unto himself, and there had not been the collaboration which should at least have led to the levels being driven at the same relative depths. Further, two of the main shafts that had been used for haulage were in such a state that it was impossible to put them in order for continuous work, whilst a third was too far away on the southern confines of the property and too small to be of much use. The fourth, although in the correct position and already down to a depth of 2,258 ft. vertical, was altogether too small. The only shaft of value on the western group was that on the Ivanhoe lease, where sinking had been done to a depth of 3,600 ft. and plats opened out to a depth of 3,320 ft.

The eastern group has always been worked as a separate entity and so far as mining is concerned this must continue as the groups are separated by the holdings of the Great Boulder Proprietary, Ltd. On this group a fairly good main shaft is in existence and is down a depth of 2,300 ft. vertical. It has always been worked by the Lake View company and for many years was a very profitable property, but latterly, like all the rest of the Kalgoorlie field, had fallen upon evil days. Under the present management this group still supplies a fairly large tonnage of low-grade ore to the mill, but development of the western group has taken precedence. A campaign of prospecting and development for the eastern group has now been outlined and is being gradually brought into effect. It is interesting to know that the first diamond drill hole put out in the new campaign intersected pay ore in virgin ground at a depth of 1,600 ft. and that this is now being opened up by driving at that

Fig. 1.—Power Plant and Mill, with Boulder Tailings Dump in Background.

level, the drive showing payable values over a good stoping width.

Reverting to the western group, it was decided to concentrate on two main haulage shafts, that on the Ivanhoe lease already in existence and the small one on Chaffers lease, which was down to a depth of 2,258 ft. and which was situated some 2,550 ft. south of the Ivanhoe shaft. The two haulage shafts on the Horseshoe lease, as previously mentioned, were in such condition, due to mining in the upper levels too close to the shafts, that any repair was out of the question. In order, however, to hold the output and even to increase it, as has been done during the period of preparation (output in 1930 was 158,218 tons and in 1931, 220,806 tons), it was necessary to work all shafts for the time being. This had the effect of keeping production costs at too high a level and probably delayed the completion of the development programme considerably, but the revenue won more than offset the cost and delay.

Fig. 2.—Erection of Chaffers Headframe.

The decision previously mentioned meant the stripping of the small Chaffers shaft from the ground level to 2,258 ft. and this in itself was no mean undertaking. The old shaft was one of three compartments measuring 11 ft. 6 in. by 4 ft. and it was decided to enlarge this to 17 ft. by 5 ft., inside measurements, to contain two compartments for skip haulage by three-ton skips, one for men and materials, and one to contain pipes, ladderway, and the balance weight for man cage. The work was put in hand in one section only at the beginning of 1931, but later, in order to expedite matters, openings at various horizons were made and work at four different levels was carried on simultaneously. The whole job is now approximately 80% complete, a substantial set of poppet legs, ore bins, and ore breaker installed, and a large steam-driven winding engine for skip haulage has been placed in position, whilst the shaft itself has been sunk to the large size from 2,258 ft. to 2,611 ft. and a winze sunk from the bottom of the shaft to 2,800 ft. This winze will later be stripped to form the shaft.

The preparatory programme called for many thousands of feet of driving, cross-cutting, and winzing, and to put this work through to schedule necessitated a complete overhaul of the existing mining methods, ventilation, and appliances. Rock-drills in use were of all types, sizes, and conditions, drill steel was mainly $1\frac{1}{4}$ in. round with a starting bit 3 in. diameter, air lines were

too small and in bad condition, with low pressures at practically all working faces, whilst the number of air-compressors at work consisted of no less than six steam-driven and one electrically operated. With the exception of the electric machine, which was retained on the eastern group and one fairly efficient steam-driven compressor in the present main engine room at Ivanhoe, there was none fit for service and they were scrapped.

Two new Belliss and Morcom compressors, each 200 cu. ft. capacity, direct-coupled to Diesel crude-oil engines, were installed in the main engine room on the Ivanhoe lease. The two last named, in conjunction with the steam compressor of Corliss valve type which was already in the main engine room, now supply all the air required on the western group, and the mains are connected also to the eastern group of leases so that air can be supplied to them in case of any shut down of the electrically-driven compressor, for which at present electric power is being purchased. Air mains of larger capacity were put down, all rock-drills were tested, worn out machines scrapped, and a series of tests carried out to determine the most suitable weight of machine, size of drill steel and diameter of bit, so that standardization of these lines might be effected. The tests showed that, for driving, a Leyner machine of about 120 lb. weight, for winzing, a jackhammer of 75 lb., and for stoping, a telescope machine of 120 lb. all with 3 in. diameter cylinders were the most suitable, whilst for the whole of the work, 1 in. steel with a starter bit of 2 in. with changes of $\frac{1}{8}$ in. for each foot of length, was the most efficient. Standardization on these lines was adopted. At first a good deal of trouble was experienced with the miners who, used to $\frac{1}{4}$ in. changes in drill bits, only changed a drill when it would bore no longer. With $\frac{1}{8}$ in. changes, if a drill is worked too long the next will not follow. Little difficulty is now experienced in this respect, the men having become used to changing the drill more frequently when in hard ground, and the result has been greatly increased boring footage per machine shift.

Another matter which received very serious consideration was the development of a standard round for drives and cross-cuts, one that would be suitable for all the types of ground met with on the properties and to the conditions under which the work had to be carried out. As much of the work has to be done under a system of forced ventilation it was essential that a round be developed, which would when blasted cause the least damage to air tubes, and for that reason the centre cut could not be adopted. Another consideration was the need for a round that could be bored in from 8 to 12 hours work, depending on the hardness of the rock, so that blasting could be regulated to take place at crib time and knock-off time only, a point strictly insisted upon under the present management, and, above all, a round that would be blasted with confidence by the miner at one firing. Such a round was quite foreign to the settled ideas of the miners, who were all contractors and who had for many years just bored any type of round they liked best, blasted when they liked, and as often as they deemed necessary to get a particular face out; the result being that the mines were full of fumes and dust throughout the shift. Need-

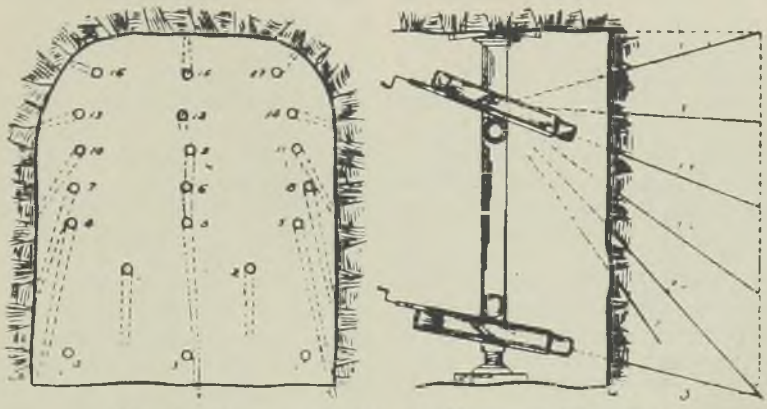


Fig. 3.—Standard Round for Moderate Ground.

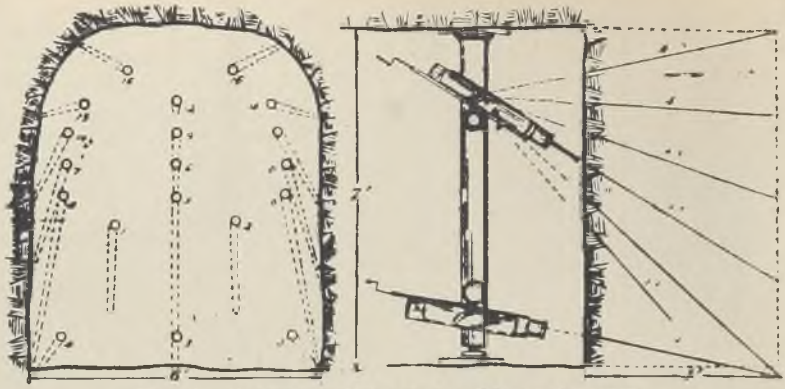


Fig. 4.—Standard Round for Worst Ground.

less to say the new ideas did not appeal to them, but in the interests of all the points were insisted upon. After a good deal of experiment a standard round, known as the bottom wedge cut, to pull 3 ft. of ground at a blast was adopted. This round calls for from 15 to 20 holes according to the type of rock and whether driving or cross-cutting. The boring footage ranges from 60 to 80 ft., and in good ground can be bored and blasted in an 8-hour shift, in medium ground in 12 hours, whilst in the very hard rock it takes 16 hours to rig, bore, and blast.

At first much trouble was experienced in getting the whole round blasted at one firing because of the difficulty in lighting the last fuses with the drive full of smoke from the first lot spit. This has now been overcome by the use of a simple contrivance which was worked out on the property. It consists merely of a timberman's staff with a very short sliding end and the usual thumbscrew. When the face is charged the fuses are threaded through holes bored in the staff in a position from the bottom upwards in the rotation it is desired the holes shall be exploded. This has overcome the prejudice against blasting the whole round at once as there is no searching for the fuse to be lighted next, there is no delay in lighting up and getting away, and there is no danger of a hole being blasted in wrong rotation to spoil the round. When all fuses are lighted the miner simply pulls the staff down and carries it away with him, the fuses readily pulling through the holes, and the staff, of course, not being jammed so tightly as to prevent it being easily removed.

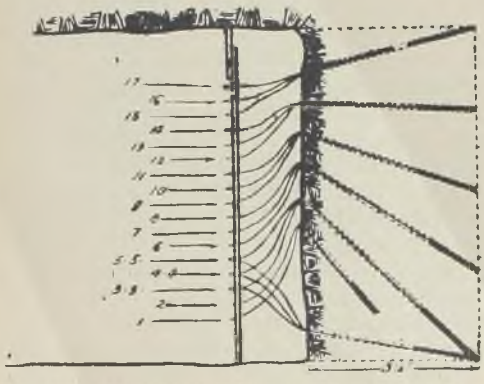


Fig. 5.—Illustrating Use of Blasting Staff.

The standard rounds adopted for moderate and hard ground are shown in Figs. 3, 4, and 5. For soft ground the principle adopted is the same except that a lesser number of holes are bored. The sketch also shows the blasting staff in use ready for blasting the face. The lighting of fuses is now done by a patent fuse igniter manufactured by the Cape Explosive Works, Ltd., this being supplied to contractors free of charge. The fuse lighter does not smoke or give off deleterious fumes and it is a boon to the workman. With its use the bad old practice of spitting fuses by the use of gelignite, which had been persisted in, notwithstanding Mines Regulations to the contrary and despite the poisonous fumes given off, has completely ceased.

Another innovation so far as this field is concerned has been the capping of the fuses on the surface. Such fuses are supplied to the miners in watertight tins, in 6-ft. fuse lengths or longer if required. This also met with much opposition, resulting in deputations of the men and their union representatives to the management, but it was insisted upon, and the complete cessation of accidents, which had become frequent on the mines with the miners doing their own fuse capping

underground, and the elimination of missed holes due to faulty capping (but previously laid at the door of faulty fuse) is the best answer, and it is more than likely that very serious trouble would be met with now were the miners to be called upon to do their own capping. Here one man makes up all fuses needed for both groups of mines in five to six hours per day.

Another matter which has speeded up development very considerably is the making of all stemming on the surface. The material used is a clayey slime, which is put through a screw machine driven by a small electric motor, the stemming being turned out to a size of 1 in. diameter and cut off to 8 in. lengths, wrapped in brown paper into cartridges, packed in cases and delivered to the levels where required. The material is ideal for the purpose, retaining just sufficient moisture to keep it soft and pliable and being quite free of grit. One man makes sufficient to keep the mines going, blasting at the rate of 500 to 600 holes per day, whereas in the old method at least 30 men lost about three-quarters of an hour per day in making up stemming; often from quite unsuitable material. The machine used is shown in Fig. 6.

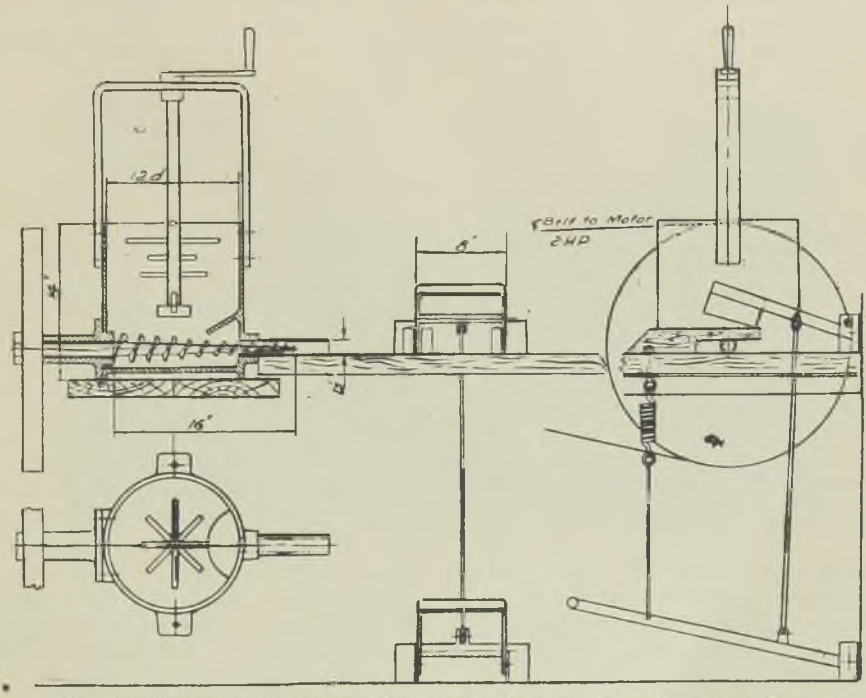


FIG. 6.—CARTRIDGE-STEMMING MACHINE IN USE AT LAKE VIEW AND STAR.

DRILL SHARPENING.—Much attention has been given to the detail of drill sharpening and tempering, as well as to the type of drill-steel used. In order to secure the best possible layout for the shop an expert in steel and steel sharpening was appointed and exhaustive tests were made as to the type of bit best suited to the ground. This resulted in the adoption of 1 in. hexagonal steel with a four point cross bit with double taper wings, the starting bit being of 2 in. diameter and changing down $\frac{1}{8}$ in. for each foot of length.

The heating of steel is carried out in oil-fired furnaces and the drill sharpeners in use consist of two Holman and three Ingersoll-Rand machines. After sharpening, the steel is allowed to cool out in the atmosphere, and is then reheated to tempering heat before quenching in salt water as it comes from the mines. The quenching is done in racks, each drill being immersed to a depth of 1 in. only in cool running water which flows from the bottom of the tank and passes away to waste at once. Tempering heat is judged by the workmen with the assistance of a magnetic indicator and a very regular hardness is secured.

Drill shanks are tempered in oil in a tank, the oil in which is constantly in circulation and a very uniform product is secured. Shanks are tested at each sharpening and if necessary are dressed up on an emery wheel. All machines are on a wooden base and the working floor is of concrete. Steel is delivered at the door of the shop by motor lorries, sorted into lengths, blown through with compressed air to make sure there is no steel with plugged holes, loaded on flat wheeled trollies and rolled over the concrete floor to the workmen. The whole of the transport within the shop is done on these flat wheeled trollies. When the steel has been tempered it is stocked in racks according to the lengths of the steel and delivery is taken again by motor lorries direct from these racks after opening swinging doors from the outside.

The whole layout has proved to be most efficient and the steel supplied the workmen is of the best possible quality in every respect. The net result of the alterations outlined is shown by a very considerable increase in footage bored per machine shift, and also in footage advanced in drives and cross-cuts per machine shift, as set out below, the figures covering the months of January, 1931, and January, 1932 :—

	Jan., 1931.	Jan., 1932.
Footage bored per machine shift	23	37
Footage advance in drives and cross-cuts per machine shift	1·0	1·35

This increase has naturally been reflected in the earnings of the miners, but it has also resulted in a decrease in the cost per foot by reason of the increased footage over which to spread overhead costs.

Another point which met with bitter opposition from the miners was in the grade of gelignite used. Prior to 1931 nothing but 70% gelignite and 90% blasting gelatine was used. A lower grade consisting of 50% gelignite with a proportion of 70% for use in the cut holes was tried out for development faces, whilst 42% grade was adopted for stoping work. This is now universal on the mines under review, and there is no longer any trouble with the men in the matter as they find it results in increased pay. Statistics show that whereas in the beginning of 1931 the average sticks of gelignite per hole, using 70% gelignite, was 6·1, with the lower grade explosive now used and better stemming the average has fallen to 5·2.

Ventilation.—The mines are ventilated by natural air currents, supplemented by "Venturi" blowers. The question of increasing the supply has received a great deal of attention and one man is employed full time in checking up the working faces. Much improvement has been effected in the past year, but it is intended to put a "Sirocco" fan of a capacity of 45,000 ft. per min. at 2·3 in. water gauge at 440 r.p.m. at the 3,260-ft. level of the Horseshoe lease. Excavations for the fan chamber have been carried out and with this installation and the completion of Chaffers shaft stripping there should be no further ventilation difficulties. The rule that no blasting shall take place except at crib time and knock-off time is being strictly enforced and, although it has met with much opposition from the miners, has resulted in greatly improved conditions as regards fumes and dust.

Transport of Ore Underground.—The old system of hand tramming has been superseded over all long haulages by the installation of electric battery locomotives, trains of ten 1-ton cars being hauled at a rate of six miles per hour on a 20 lb. rail track. For short distances hand tramming is still in vogue, but the old 14 cwt. box car, running in metal bearings, has been replaced to a great extent by 1-ton side-dump cars with roller bearings. The latter have proved successful and arrangements have been made to utilize them wherever possible.

In a few places the box type will have to be retained by reason of the fact that in some of the old drives the level timbers have closed to such an extent that only a narrow car can be run. In all instances flat sheets have been or are in course of being replaced by points and crossings and curves. This has boosted the hand tramming figures from 10 cars to 14 cars per trucker shift during the year 1931.

Stoping Methods.—The methods in vogue consist of shrinkage and cut-and-fill on the rill system. At one time there were many flat-back cut-and-fill stopes, but these have gradually been worked over to rill cut-and-fill, to facilitate filling of worked out ground. Fill consists of sand from old sand dumps on surface, loaded on trains hauled by steam locomotives, and dumped down main sand passes. The trains are loaded from bins which are filled by the operation of slusher hoists. Timbering for stoping consists of lagged stulls where the ground is suitable and widths narrow, but in most instances

sets of native round timber are used. In the early days the whole of the lode on the level floor was taken and sets were close boxed with sawn timber. After a period of time side pressure caused the breakage of set legs and collapse of the haulage ways. To obviate this trouble, the system has now been adopted of driving to a height of 7 ft. and a width of 6 ft., irrespective of width of lode. The first stope is taken off to the same width, set timbers are then stood in place, the caps blocked from the walls and lagged over, but no side lagging is used. All timbers are cut at the surface and sent below a standard size. After the lagging has been loaded with waste or fill, and ore extend to the wall rock. Thus there is little or no wear on the bottom boards of chutes.

Shrinkage stoping, except in narrow portions of the lode, has not proved a success in the western group. The working of a number of parallel ore-bodies with numerous branches running continuously for hundreds of feet, both in depth and strike, weakens and shatters the country lying between the bodies to a very great extent. In consequence much unpayable rock is mixed with the ore when a shrinkage stope is finally drawn and the dilution thus effected presents a serious problem. For this reason, except in isolated ore shoots, where the work of getting fill into place

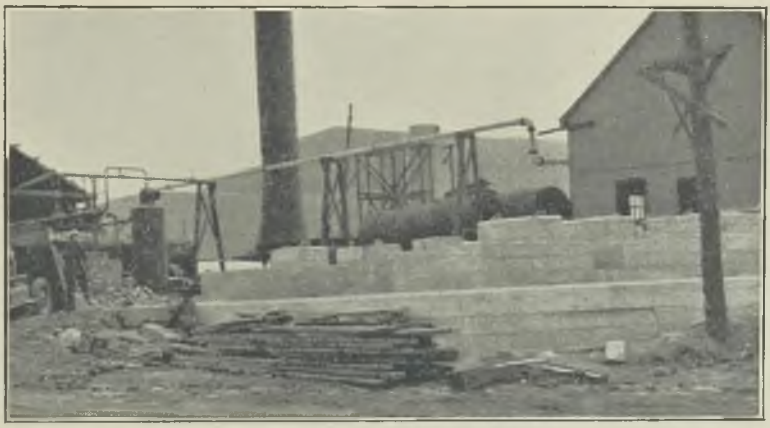


Fig. 7.—Foundation at Chaffers for Horseshoe Winder.

chutes and manways built, the stope is opened out to the width of the ore-body. The system calls for the loss of a certain amount of ore in drive walls, but it leaves the set legs free from side pressure and allows of easing the ground should such become necessary. A standard ore chute for the run of ore from stopes has been adopted, a sketch of same being shown in Fig. 9. For chutes intended to serve the particular stope only wooden stopper boards are used, but in main ore passes and in all positions where electric trains can be loaded an iron arc door is substituted. The whole has been standardized, chutes being cut out at the surface saw bench and sent underground ready for erection. This does away with all cutting of timber below with the consequent waste of timber and time. It will be noted that timbers for bottoms of chutes are all the same length and in most instances these bottoms do not entails too much expense, and in known narrow ore occurrences, the system has been abandoned in favour of the rill cut-and-fill system. The sand fill being used is ideal for the purpose, but the quantity available near at hand is limited. Plans are being made by which future requirements will be recovered by the "caving" system, a block on the western wall of the group having been selected.

On the eastern group of mines shrinkage stoping is the rule. Although dilution is also present here it is not so serious as on the western group, besides which the ore occurrences as worked in the past were isolated from each other and no system of mullock passes was ever instituted below the shallow levels. It is possible that the present diamond-drilling campaign will link up the different ore shoots, in which case the matter of stoping methods here will receive further attention.

Pumping and Bailing.—The quantity of water in the mines is not heavy. In the eastern group it amounts to 12 gallons per minute and is dealt with by haulage in the ore skips from dams. On the western group it is rather heavier and amounts to approximately 50 gallons per minute. Up to 1931 this was dealt with by pumps driven by compressed air and bailing on the separate mines, but early in that year provision was made to drain all water to the old Horseshoe main shaft, which is in too bad a condition to continue as a haulage shaft. At the 3,260-ft. level a vertical Triplex plunger pump of a capacity of 60 gallons per minute was installed, driven by an electric motor. This raised the water to the 200-ft. level from which at first it gravitated to a bailing shaft and was hauled in tanks to the surface. Later in the year electrically-driven pumps were installed at the 2,000 and 1,000-ft. levels and all water making along the lines of lode is raised by these pumps to an elevated tank from which it gravitates to the treatment plant and is used for the sluicing of residues to dumps. The only water now bailed is a flow above the 800-ft. level in the bailing shaft itself. Thus the pumps relieved the haulage shafts and made possible the increased ore output.

Power lines carry current at a voltage of 3,300, passing through transformers when it is reduced to 550 volts for the motors. The same source of supply is used for charging the battery haulage locomotives at stations underground.

On the surface each shaft was at the beginning equipped with a complete ore breaker station under steam power and requiring attendants for each with a repair gang to keep them in working order. With the new centralized milling plant it was decided to concentrate all breaking of run-of-mine ore at the new main shaft at Chaffers and at the mill itself. Chaffers shaft is so situated that the ore hauled will be delivered from a breaker at the shaft by inclined elevator belt direct to the cone crushers mentioned subsequently in describing the milling section. The old breakers at the different shafts were thrown out of commission and a very considerable saving thus effected.

Ore Transport from Mines to Mill.—With the exception of that from Chaffers shaft the method of transporting the ore from mine bins to mill is by trains of side-dumping cars of two tons capacity, hauled by small steam-driven locomotives, a load of 40 tons being hauled over a two-foot gauge line on 30 lb. rails. The cost of transport, for loading and discharge of trains, train crew wages, and fuel and water for locomotives, amounts to 1·75d. per ton.

Fig. 8.—Chaffers Boiler Plant and Old Headframe.

Ore Treatment.—The flow-sheet of the new mill is shown in Fig. 12.

Primary Breaking.—This is done in two stages. The first consists of breaking the run-of-mine ore to a 4 in. size and is carried out in a No. 7 Gates gyratory ore-breaker of an hourly capacity of 120 tons. This breaker is installed in a pit 30 ft. below ground level and the ore is delivered to it from two bins of 90 tons capacity situated on the north and south sides of the breaker pit, the railway from the mines running over the top of the bins. Another breaker of the same size and capacity is installed at Chaffers shaft and the streams of ore from these breakers meet at the Symons cone crushers.

The broken ore is delivered to a conveyor

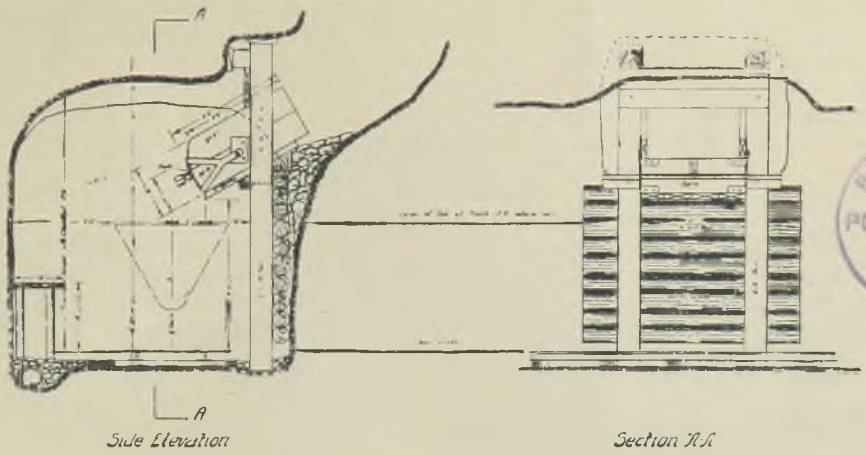


FIG. 9.—STANDARD ORE CHUTE AT LAKE VIEW AND STAR.

and elevated to two Symons cone crushers, passing in transit under an electro-magnet, which removes all tramp iron and broken steel before reaching the cone crusher section. These crushers break the ore to half-inch size and deliver to a belt conveyor carrying to the bins. It is intended to instal a further crusher between the Symons cones and the belt, to give a still finer mill feed. Whilst in transit to bins the ore is sampled automatically and passes over a Merrick weightometer.

Coarse Grinding.—This is carried out in wet-type ball-mills, and is the point of departure from the old methods of dry milling. The mills are fed by automatic feeders, are of the Allis-Chalmers type, 6 ft. by 5 ft., and are run at 26 r.p.m. They have a capacity of 10 tons per hour, with a mill feed of 20% plus half inch and discharge of 17% plus 20 mesh. From the ball-mills the pulp flows over corduroy tables, which remove the free gold, amounting to approximately 30% of the total gold content of the ore. The tables are situated on a platform in full view of the workmen and are securely enclosed within a strong mesh wire. Corduroys are washed every eight hours under the supervision of a responsible official and all entrances to the enclosure are locked except at actual washing times. The product of the tables is treated in an amalgamating barrel situated in the clean-up room.

Fine Grinding.—From the tables the pulp passes to drag classifiers in closed circuit with four tube-mills each 22 ft. by 5 ft., run at a speed of 29 r.p.m., the pulp being ground to 85% minus 200 mesh. From this point the product of all tube-mills gravitates to a common sump and is pumped by centrifugal pumps to two Dorr thickeners, each 50 ft. in diameter, the overflow from which returns to the mill circuit. A third Dorr thickener is shown on the flow-sheet. This will later be put in commission for

FIG. 10.—POWER PLANT, WITH MILL OIL TANKS IN FOREGROUND.

dewatering tailings so that the whole of the residues may be sluiced to dumps by the aid of salt water from the mines. At the moment, tailings from flotation machines are run away in the fresh water, which is returned to mill circuit by centrifugal pumps.

Oil Flotation.—The thickened pulp passes to the flotation machines, two in number, of the Denver "Sub. A" Fahrenwald type. A third machine of the same type is to be installed later, as shown in the flow-sheet. The reagents used are thiocarbanalide as a conditioner (0·09 lb. per ton) and Aerofloat as a frother (0·05 lb. per ton). The thiocarbanalide enters the circuit at the tube-mills and the Aerofloat at the head of the flotation boxes. Concentrates recovered from the first three cells pass direct to the concentrate sump, whilst from the other cells the concentrate passes along a common launder and through a frothing gate, the overflow from which also passes direct to the concentrate sump and underflow is returned to the head of the flotation unit.

The recovery of gold values is most satisfactory. The concentrate won represents only some 10% of the original ore and has an average value of over 300s. per ton, whilst the balance of 90% of ore after leaving the flotation unit is discharged to a tailings dump with a gold content of less than 3s. per ton. Before this method of treatment was installed in 1931, the whole of the ore had to be roasted before cyanidation. This, for an output of 30,000 tons of crude ore per month, would have necessitated the operation of not less than 12 roaster units, with the attendant high cost for firewood. The roasting of concentrate from the same tonnage of ore will require three roaster units only, whilst the high sulphur content of the concentrate eliminates the use of fuel entirely. In fact, once started, combustion is rather too rapid and the roasting heat has to be regulated by the opening of a certain number of side inspection doors. With wood fuel costing 17s. 6d. per ton the saving here may be easily visualized.

Reverting to the treatment process. From the pump sump the concentrates are pumped to two 25 ft. diameter thickeners, the overflow from which returns to the mill circuit and the thickened product goes to a "surge" tank feeding two small Oliver filters. The liquid drawn off the filters is returned to the mill circuit, whilst the concentrate cake falls on two Lowden driers, passes over, and is dropped on a conveyor which carries it to the roasting section. At this point it is intended to instal a further weightometer and automatic sampler to determine with accuracy the tonnage and value of concentrate passed to the roasters.

FIG. 11.—50 FT. THICKENERS, HORSESHOE DUMP IN BACKGROUND.

Roasting of Concentrate.—This is carried out in Edwards duplex roasters each having 56 rotary solid rabbles. From the roasting section the concentrate is passed by means of push conveyors to a mixer where cyanide solution is added and the whole then joins the pulp coming from the old milling section, part of which is still in operation treating oxidized ore and tributers' parcels. The combined pulp goes through the usual stages of agitation with cyanide solution and is then passed over Oliver filters, which have been installed in place of the old cumbersome Cassells presses. The residues go to a mixer where they are mixed with salt water from the mines and pumped to

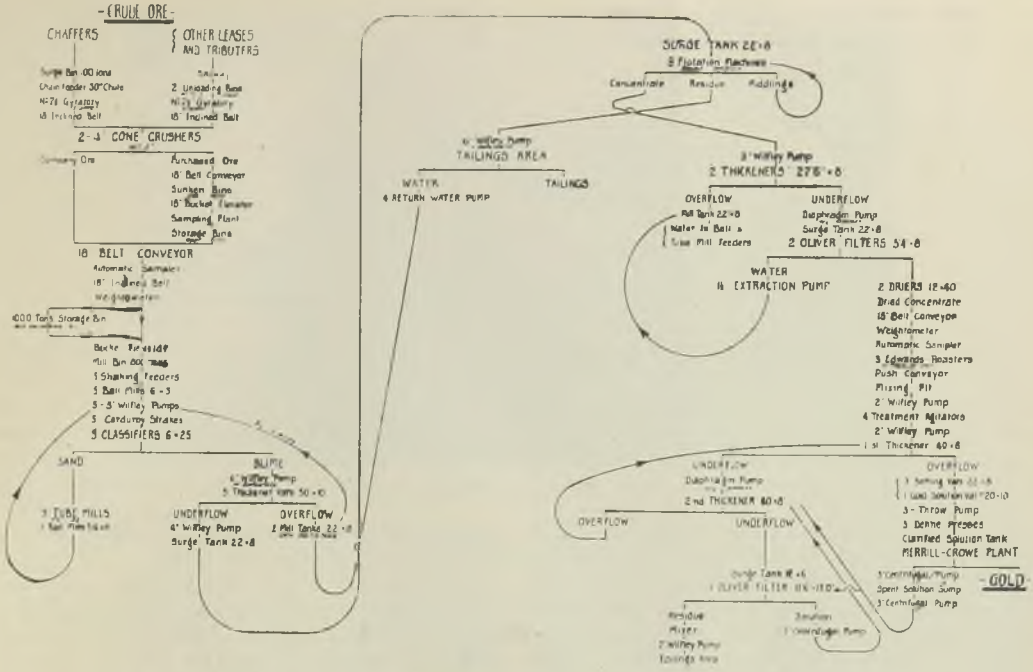


Fig. 12.—Flow-Sheet of 30,000-ton Wet Crushing Mill at Lake View and Star.

tailings heaps. It may be stated that the whole of the treatment up to this point has been made in fresh water, which is being purchased from the Government after having been brought by pipeline a distance of 360 miles. Whilst much of the mine water pumped has to be run to waste (though it would be quite suitable for the treatment plant), the policy of the Government prevents its use for any purpose excepting the sluicing of residues to dumps. This policy is carried into effect by a sliding scale of charges which allows considerable rebates to those mines using purchased water only. As the water from the mines is unsuitable for any other purpose but milling and there is insufficient for that, no mine could get along without purchasing considerable fresh water, and therefore it is found more economical to purchase the whole supply, although to an observer it appears an economic waste to see thousands of gallons of fresh water pumped 360 miles to be used on work for which the salt water could be utilized.

Precipitation.—In this department the gold-bearing solution passes through a Merrill-Crowe precipitation plant, the whole being enclosed in a locked building in which the amalgamation of the product of the corduroy tables previously referred to is also carried out. In this room the balance of the work to the production of gold bars is done, but it is not the purpose of the present article to follow it in detail as the treatment does not differ in any material respect from the practice carried out in the past.

The old plant, part of which is still in operation treating tributers' parcels and oxidized ore from company workings, consisted of stamp mills, dry-crushing ball-mills, roasters, corduroy tables, agitation with cyanide solution, filtration by the Cassell process, and zinc-box precipitation. The whole layout is obsolete and will shortly be closed down, all treatment being transferred to the new plant.

Power.—All units are operated electrically, each having its own motor and being driven by Tex Rope drives, eliminating belting and line shafting with the attendant friction losses. Up to a few months ago all current was purchased from the Kalgoorlie Power Corporation, but as that company generates its power by means of wood-fired steam boilers and as this wood costs 17s. 6d. per ton delivered at their works, it naturally follows that the cost per unit is high. Owing to the inability of the Power Corporation to supply the mine with the whole of the power required it was decided to instal a power

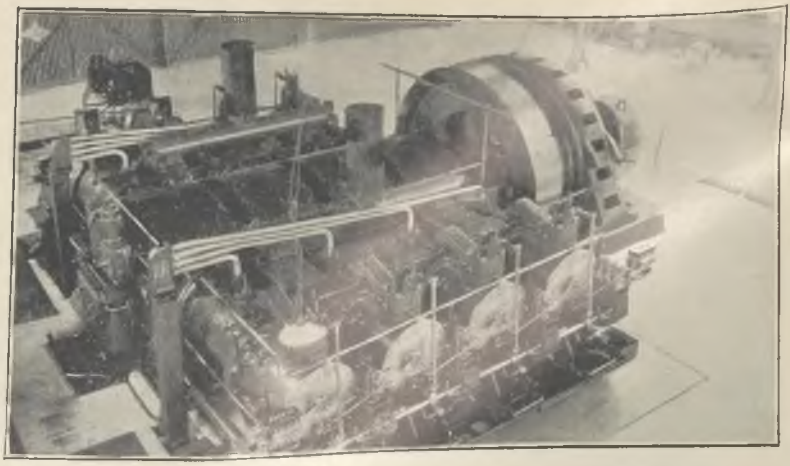


FIG. 13.—ONE OF THE CRUDE-OIL UNITS IN THE POWER PLANT.

plant consisting of two 8-cylinder Diesel crude-oil engine units direct-coupled to 3,300 volt generators. One unit was ordered from England as a plant of such size is not manufactured in Australia, and the foundations for both units were completed. The second unit is expected to arrive on the mine within the next two months and a third unit of similar capacity has since been ordered.

Provision for the proper maintenance of plant has not been lost sight of and all repair work is carried out in the mine shops, which are centrally situated and which consist of a well-equipped engineering shop where all skips, cages, trucks, and other mining equipment are made and repairs done, an electrical engineering shop for all motor repairs, a plumber's shop, besides the usual blacksmith's shops, and last, but not least, a rock-drill repair shop, where rock-drills are kept to a pitch of the utmost efficiency by expert workmen.

The enterprise of the present company and the success which is attending the efforts of the management in all directions has had a wonderful effect upon the district. As one instance, it might be stated that at the end of 1928 it was practically decided to close the School of Mines at Kalgoorlie because of the dearth of students and it was only after strenuous objection on the part of the residents of the goldfield that such was not effected. In the year 1931 there were no less than 65 students working on the Lake View properties alone.

In concluding this description of the modernization of conditions on the Lake View and Star properties, the author wishes gratefully to acknowledge his indebtedness to other members of the staff for the help they have given him in its preparation.

THE DESIGN OF ROTARY SCREENS

By H. G. SMITH, B.Sc.

The author reviews the means whereby the risks involved in the design of revolving screens may be minimized.

The rotary method of screening has been employed in the dressing of minerals, rock, and gravels for many years, and it has still wide applications. At first sight, therefore, it may seem strange that the knowledge of the design of such screens is so imperfect, and that so few attempts have been made to put forward rules to help the prospective user in their design. When, however, one considers the varieties of material dealt with by rotary screens and their wide differences in physical properties, it becomes at once apparent that the formulation of such a rule is a very difficult task, and that the design of an efficient rotary screen is something of a hazard. The object of the writer in the present article is not therefore to suggest a definite rule from which these screens can be designed, but to put forward means whereby the risks of this hazard can be minimized.

The first step in the design of a rotary

screen is the determination of its diameter. This can readily be obtained from the following formula :—

$$D = 7{\cdot}66\sqrt{\frac{W}{d}}$$

where D = the diameter of the screen in inches.
W = the desired capacity of the screen in tons per hour.
d = the approximate specific gravity of the material passing to the the screen.

Having ascertained the diameter of the rotary screen, the next step is to determine the lengths of the various sections of the screen. For this purpose the figures shown in Table I are given. The use of this table will probably be best illustrated by means of a numerical example :—

In a gravel plant the feed to a rotary screen is to be 100 tons per hour. A laboratory analysis of the feed shows that it is composed as follows. The approximate specific gravity of the material in the feed is 2.

Minus 1 in. — 50 tons.
plus 1 in., minus 1½ in. — 30 tons.
plus 1½ in., minus 2 in. — 10 tons.
plus 2 in. — 10 tons.

1. *To find the Diameter of the Screen.*—

$$D = 7{\cdot}66\sqrt{\frac{W}{d}}$$

$$= 7{\cdot}66\sqrt{\frac{100}{2}}$$

$$= 54\tfrac{1}{2} \text{ in.}$$

As this is not a commercial size a 60 in. diameter screen will have to be employed.

2. *To find the Lengths of the various screen sections using Table I.*—It will be seen from the screening analysis of the feed that the maximum ring size in the feed will be 2 in. Turning to the table, a screen diameter 60 in., a maximum ring size in the feed of 2 in., and a desired product of 1 in. ring it will be found that each foot of length of the screen section will take care of 2·6 × 2 tons per hour, that is 5·2 tons per hour. As 50 tons per hour has to be treated, the length of the 1 in. section will be 50/5·2 ft., that is 9·6 ft.

TABLE I

Screen Diameter. (*inches*)	*Max. Ring-size in Feed.*[1] (*in.*).	*Ring-size of Products and Volume Factor per Foot of Length.* (*Volume Factor × Specific Gravity = tons.*)												
		½ *in.*	¾ *in.*	1 *in.*	1¼ *in.*	1½ *in.*	1¾ *in.*	2 *in.*	2½ *in.*	3 *in.*	3½ *in.*	4 *in.*	5 *in.*	6*in.*
24	1	·75	1·0	1·1	—	—	—	—	—	—	—	—	—	—
	2	·4	·6	·75	·8	1·0	1·05	1·15	—	—	—	—	—	—
	3	·35	·45	·55	·65	·75	·85	·90	1·0	1·15	—	—	—	—
32	1	1·25	1·6	1·85	—	—	—	—	—	—	—	—	—	—
	2	·75	1·0	1·25	1·4	1·6	1·7	1·85	—	—	—	—	—	—
	3	·50	·75	·90	1·1	1·25	1·35	1·45	1·65	1·85	—	—	—	—
40	1	1·75	2·25	2·6	—	—	—	—	—	—	—	—	—	—
	2	1·05	1·4	1·75	2·0	2·25	2·45	2·65	—	—	—	—	—	—
	3	·75	1·05	1·3	1·55	1·75	1·9	2·1	2·35	2·65	—	—	—	—
	4	·6	·85	1·05	1·25	1·40	1·6	1·75	2·0	2·25	2·45	2·65	—	—
48	1	2·1	2·7	3·15	—	—	—	—	—	—	—	—	—	—
	2	1·25	1·7	2·1	2·4	2·7	2·95	3·15	—	—	—	—	—	—
	3	·90	2·25	1·55	1·85	2·1	2·3	2·5	2·75	3·15	—	—	—	—
	4	·70	1·0	1·25	1·50	1·7	1·9	2·1	2·4	2·7	2·95	3·15	—	—
	5	·55	·8	1·05	1·25	1·45	1·6	1·8	2·1	2·35	2·6	2·8	3·15	—
60	1	2·6	3·35	3·9	—	—	—	—	—	—	—	—	—	—
	2	1·55	2·1	2·6	3·0	3·35	3·65	3·9	—	—	—	—	—	—
	3	1·1	1·55	1·9	2·3	2·6	2·85	3·1	3·55	3·9	—	—	—	—
	4	·85	1·25	1·55	1·85	2·1	2·35	2·6	3·0	3·35	3·65	3·9	—	—
	5	·7	1·0	1·3	1·55	1·8	2·0	2·25	2·6	2·95	3·25	3·5	3·9	—
	6	·6	·85	1·1	1·35	1·55	1·75	1·95	2·3	2·6	2·9	3·15	3·55	3·9
72	1	3·15	4·05	4·7	—	—	—	—	—	—	—	—	—	—
	2	1·85	2·55	3·15	3·6	4·05	4·4	4·7	—	—	—	—	—	—
	3	1·35	1·85	2·3	2·75	3·75	3·45	3·75	4·25	4·7	—	—	—	—
	4	1·05	1·5	1·85	2·25	2·55	2·85	3·15	3·6	4·05	4·4	4·7	—	—
	5	·8	1·2	1·55	1·85	2·15	2·4	2·7	3·15	3·5	3·9	4·2	4·7	—
	6	·7	1·05	1·35	1·65	1·85	2·15	2·35	2·75	3·15	3·5	3·75	4·3	4·7

[1] The maximum ring-size in the feed is taken as the size of the ring through which 90% of the material will pass.

TABLE II

GOOD PRACTICE

Diam. of Screen in inches.	R.P.M. for Choking of Apertures.	Ore. R.P.M.	Ore. Peripheral Speed. Ft. per min.	Coal. R.P.M.	Coal. Peripheral. Speed. Ft. per min.
30	63	16 to 35	123 to 275	27 to 30	212 to 235
36	56	20 ,, 30	189 ,, 283	23 ,, 26	217 ,, 245
48	48	12 ,, 22	151 ,, 277	19 ,, 20	239 ,, 252
60	43	11 ,, 13½	173 ,, 213	15 ,, 16	236 ,, 252
72	40	11 ,, 13	207 ,, 245	12 ,, 13	226 ,, 245
84	35	10 ,, 11½	204 ,, 253	8 ,, 11	176 ,, 242

Similarly, the length of the 1½ in. section will be $30/3 \cdot 35 \times 2 = 4 \cdot 5$ ft., and that of the 2 in. section $10/3 \cdot 9 \times 2 = 1 \cdot 3$ ft. Thus the length of the sections should be, say, 10 ft., 5 ft., and 2 ft. 6 in., thus keeping the length of the sections in multiples of 2 ft. 6 in.

It is a common practice in many dressing operations to enclose the main screen, or, more often, the first section of the main screen, with what is called a sand jacket. Since a sand jacket is of greater diameter than the main screen its peripheral velocity is also much greater, with the result that its screening efficiency is greatly diminished. Furthermore, the sand jacket receives its feed, which also contains a large percentage of fines, over the greater portion of its length and hence one must be very liberal in calculating the length. The table can be used for this purpose by assuming the sand jacket to be of the same diameter as that of the main screen and employing one half the volume factor figures given in the table.

Supposing, in the quoted example, the 50 tons of minus 1 in. consisted of 30 tons of plus ½ in. and 20 tons of minus ½ in., and a separation was to be made by means of a sand jacket. In this instance the maximum ring size in the feed would be obviously 1 inch. Hence the length of the sand jacket equals $\frac{20}{\frac{1}{2} \times 2 \cdot 6 \times 2} = 7$ ft. 10 in. That is to say, 8 ft. would be a suitable length.

SPEED OF ROTARY SCREENS.—The factor of speed operates in two ways :—

1.—When the speed is too low the bank of ore becomes too thick and the capacity of the screen along with the screening efficiency falls.

2.—When the speed is too high the centrifugal force produced causes the choking of the apertures of the screen and again poor screening results.

It has been shown many times that the efficiency of a revolving screen is generally low at slow speeds and increases with increasing velocity until the material is carried about one-third of the way up the screen when the efficiency is a maximum. It would appear therefore that the speed of an ore trommel should be such that the material is carried one-third of the way up the screen. In the United States revolving screens for the sizing of coal have average peripheral speeds of 200 to 250 ft. per minute, whilst in England the range is from 150 to 200 ft. per minute. Most authorities hold that peripheral speeds of not exceeding 200 ft. per minute are best for ore and crushed rocks. In Table II a table of speeds as recommended by the U.S. Bureau of Mines[1] is reproduced.

SLOPE OF ROTARY SCREENS.—The greater the angle of inclination of a rotary screen, the more rapidly does the material flow through it, but it must be borne in mind that the opportunity of the material to pass through the apertures is less. The best slope for coal screens is about ⅞ to 1 in. per foot, wire cloth screens requiring a slightly greater angle of inclination than punched plates. For the wet screening of ore and crushed rock inclinations of ½ to 1¼ in. are found to be best, whilst for dry cleaning the inclination required is 1 to 1½ in. per foot.

POWER REQUIRED.—

(1) For coal the power required approximates to $\frac{\text{Feed in tons per hour}}{10}$ B.H.P.

Or $\frac{D \times L}{8}$, where D = diam of screen in ft.

L = length of screen in ft.

(2) For ore the power required approximates to $\frac{D \times L}{4}$ for heavy trommels on trunnions.

[1] "Screening and Sizing of Coal, Ore and Other Minerals," Bulletin 23A, U.S. Bureau of Mines, 1925.

Or $\frac{D \times L}{12}$ for light shaft screens.

Empty screens take about 50% of the power.

Dimensions of Apertures.—Trommels with a round hole screen give a smaller maximum undersize than that indicated by the size of the hole.

Diameter of round hole perforation *in.*	*Max. diam. of Undersize (ring)* *in.*	*Max. diam. of Undersize (cube)* *in.*
$\frac{1}{2}$	$\frac{3}{8}$	$\frac{9}{32}$
$\frac{7}{8}$	$\frac{3}{4}$	$\frac{1}{2}$
$1\frac{3}{4}$	$1\frac{7}{16}$	1
$3\frac{1}{2}$	$2\frac{7}{8}$	2
7	$5\frac{3}{4}$	4

It is recommended that the diameter of the perforations should be 25% greater than the ring-size of the product desired, for the smaller sized holes, and 12½% for the larger size.

The spacing of holes varies a great deal, often holes of less than ¼ in. diameter are spaced at a distance apart equal to their diameters, and holes over 1 in. diameter at distances equal to their radius. The following rule may prove of value :—

$$x = \sqrt{\frac{\text{Area of Perforation}}{0 \cdot 43}}$$

where x = the distance between the centres of the perforation.

DIAMOND DRILLING COSTS AND PRACTICE

By G. CHESTER MASTER

The author gives the results of work carried out at the Star Mine, Northern Rhodesia.

The data and notes contained in the following article were compiled in the course of work done in making an examination of and doing certain prospecting work at the Star mine, in Northern Rhodesia. The work had to be completed in a limited time, and the 10,700 ft. drilled actually took nine months to finish, with two drills in use. The property is situated 12 miles north-west of Lusaka town and 5½ miles west of the Rhodesia–Congo railway, in Northern Rhodesia.

The examination in question was intended to prove the continuance in depth and extent of an ore-body containing zinc silicate in the form of willemite, ($2ZnO.SiO_2$), which had been exploited on a fairly extensive scale from the surface down to a depth of 50 ft. by open-cast working.

The rocks in the district are of Pre-Cambrian age and of the Broken Hill Series. They consist of dolomitic limestone underlain by schists and phyllites. Fractures and small cavities in the dolomite are fairly frequent, and when encountered, the water in the bore-holes is lost and in most cases the hole has to be cemented. Generally speaking, however, the drilling is good in the limestone and dolomite, when free from cavities, but bad in the schists and phyllites. Soft bands of schist often cause the formation of a thick clay, which makes the drill rods stick. In places the phyllites have exceptionally hard bands or veins of a cherty quartz and these are hard on the bits.

In selecting the diamond drills for this work the following points had to be considered :—That although, in all probability, most of the holes to be drilled would be shallow ones (approximately 300 ft.) it might be necessary to put down a few holes of from 1,000 to 1,200 ft., but a large drill for deep boring was not to be contemplated. On account of the limited time available the drilling programme had to be carried right through the rainy season, so that the

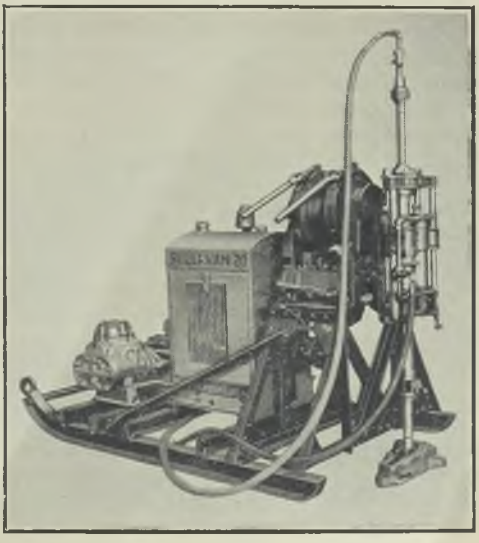


Fig. 1.—Sullivan "20" Drill.

FIG. 2.—DRILLING AN INCLINED HOLE.

question of fuel for power was of importance. The abundance and low cost of firewood would seem at first sight to point to the use of steam, but in practice, especially during the rainy season, much time is always lost through wet firewood, waiting for steam pressure to rise etc., so that petrol-driven drills were finally chosen and the resulting economy is noted when the efficiency is taken into account and not in the actual cost of the fuel used.

The two drills used for this work were of Sullivan manufacture, and gave complete satisfaction. The following is a brief specification of the equipment. The larger drill was of the type known as a "Sullivan 20," driven by a direct-connected 10 h.p. petrol engine, mounted, together with the drill and pump, on a base in the form of a skid or sledge with the ends turned up, so that the entire unit can easily be hauled by oxen etc. from one site to another without dismounting. This drill has a hydraulic feed and a capacity up to 1,200 ft. A fan of holes can be drilled from the same set up if desired without shifting the drill, which is a great advantage. The outfit is shown in Figs. 1 and 2. The smaller drill used was a "Bravo 300" belt-drive, screw-feed, 6 h.p. petrol-driven engine. (See Fig. 3.)

It was found advisable to standardize on "E" rods and fittings for both machines, so that spares etc. could be used on either, this resulted in all cores being 15/16 in. in diameter.

To protect the drills in the rainy season and to avoid delays while the heavy rains were on, a sectionalized framework was made to close in the drill, pump, engine etc. entirely. This was bolted together and loose galvanized sheets placed on top, suitable openings being left or cut for rods and casing to pass through. The sides were protected by sacking nailed to the framework and at the ends loose curtains of sacking could be raised or lowered as desired. In this way only one helper was exposed to the weather and he only when lowering or raising the rods, so that it was a rare occurrence for drilling operations to stop, even during the heaviest of tropical storms.

All the drilling was done within a radius of one mile. A central 20 h.p. boiler provided steam for two pumps, which worked alternatively in two 70 ft. shafts, delivering water to storage tanks raised six feet above the flat surrounding country. From these tanks 1 in. pipes were laid to supply each drill with water wherever located. A small central electric lighting plant was also used to provide light for the camp and drills as required. Two 10-hour shifts were worked and the results obtained were found to be better than when working three 8-hour shifts. During nine months only one shift was lost on each drill.

MOVING DRILLS.—The longest time ever taken for this was one complete shift and the moving consisted of dismantling the drill, rig, water line, electric light line, pulling casing and the transport of the outfit to the new site (any distance up to one mile) and of installing everything ready for operation. The "Sullivan 20" drill, as already mentioned, was usually dragged by oxen on its base to the new location, but with the Bravo it was found simpler to lift it bodily

FIG. 3.—SULLIVAN "BRAVO 300" DRILL.

FIG. 4.—MOVING THE BRAVO DRILL BY OX WAGON.

on to an ox-wagon with a block and tackle. (Fig. 4 shows this drill being transported on a wagon.)

CARBONS.—Brazilian carbons of 1½ carats each were used, although at times "Premier" borts were intermixed with them. In a few cases hard Premier stones were encountered and these gave good service, thus decreasing the carbon cost, Premier borts costing approximately one-fifth of the price of Brazilian carbons. Several kinds of carbons were employed, but Patrick blunt-edged carbons gave the best results.

On three occasions bits were lost or stuck, but in each instance they were recovered, either by fishing or by reaming around them. The carbon loss of 0·35 cents per foot drilled is exceptionally low and especially so for Northern Rhodesia and it can only be attributed to careful setting, fairly good formation for drilling, competent runners, and a good selection of carbons.

CORES.—For most of the time double-core barrels were used and the core when taken from these was placed in a wooden box five feet in length with ten grooves and a wooden top, which was locked with a padlock when the shift was completed and taken, together with the shift report, direct to the core room. The cores were then carefully examined, split, sampled when mineralized, stored in shelves 5 ft. in length and placed in racks 6 ft. high, the shelves being numbered as follows:—On left-hand side the box number was painted; in the centre the drill-hole number; and on the right the position of the footage represented by the core in the shelf. (Fig. 5 shows the shelves in the rack and also the core-box—as brought in from the drill—being opened.) The mineral willemite was found to core well and when drilling through the ore-body the percentage of core recovered was usually high, but the wear on the carbons was heavy,

FIG. 5.—CORE-SHELVES ON RACK.

FIG. 6.—PANORAMIC VIEW OF

especially so when the zinc mineral was associated with specular iron, as was often the case.

All sludge passed through specially constructed sectionalized boxes and samples were taken for every five feet drilled, except in special cases, where the formation suddenly changed. The sludge samples were assayed and the results served as a check on the core samples or were used when no core was recovered.

The records kept were as follows :—

A " Daily Shift Report " was filled in by the runner and handed in with the core-box after every shift. This report contained the following details :—Date, shift, hole number, " Terminating at," " Started at," feet drilled, and amount of core recovered. Any change of formation was noted under " Distance, From-To " and under " Remarks " such details as the colour of the formation or the sludge, cavities, fractures, loss of water, cause of stoppages, etc., were set out, the report being signed by the runner. (Table 1.)

A second report was the " Diamond Bit Report." This was made out by the setter every time he mounted a bit and it kept a good check on the carbon loss. The data compiled from this report is useful in many ways. For instance, when more than one drill is being operated it may be of interest to compare the carbon loss between the different drills in use and this can easily be done from these reports. (Table 2 is an example of this report.)

The third report was drawn up on the completion of each bore-hole and is called " The Diamond Drill-Hole Report." (See Table 3.) It contains the following information :—Drill-hole number, date started, date completed, astronomical bearing, inclination, location of collar (including latitude, departure, and elevation), followed by full geological details of the entire formation passed through, with assays of core and sludge when taken. This report should always be accompanied by a plan showing the exact location of the bore-hole and a geological section with assays.

COSTS.—These were kept in detail and in looking at the results it must be borne in mind that the drilling took place in the centre of Africa, far from where diamond drills are manufactured, and that the indirect costs include the amortization of 50% of the entire cost of the two drills, also the building, equipment, and the running of an assay office.

The direct drilling cost of 8·1s. or $1·968

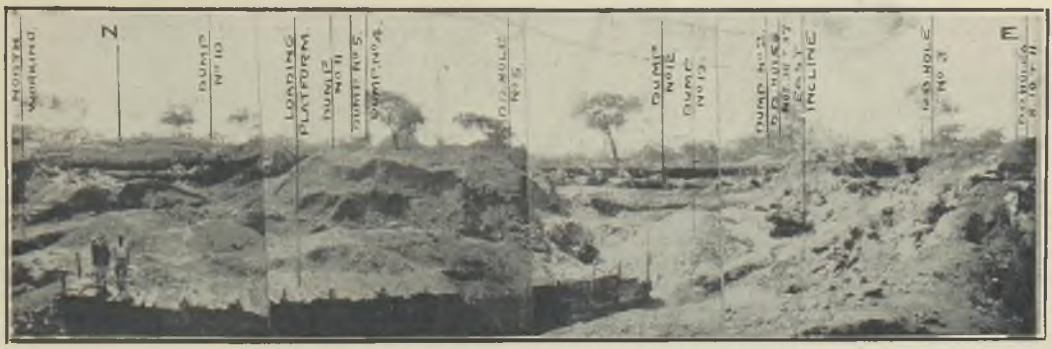
TABLE 1

DAILY SHIFT REPORT

Date	Nov. 25, 1930	Terminating at	350 ft. 6 in.
Shift	Day	Started at	336 ft.
Hole No.	36	Drilled	14 ft. 6 in.
Drill No.	Bravo	Core Recovered	11 ft. 3 in.

Distance			
From	*To*	*Thickness*	*Remarks*
336 ft.	340 ft.	4 ft.	Sludge a white colour.
340 ft.	345 ft.	5 ft.	Red irony colour, a 3 in. cavity at 345 ft., lost water.
345 ft.	348 ft.	3 ft.	White to grey colour.
348 ft.	350 ft. 6 in.	2 ft. 6 in.	" " " "

Runner . . H. Smith.



THE OPEN-CAST, STAR MINE.

FIG. 7.

per foot drilled, compares favourably with drilling anywhere in the world, and the total cost of 17·5s. or $4·252 is lower than any costs attained before in Northern Rhodesia

TABLE 2

DIAMOND BIT REPORT

Set Up 1 Hole No. 42 Bit No. 86

From.	*To.*	*Feet Drilled.*	*Core.*	*Material.*	*Runner.*	*Date.*	*Shift.*
75 ft.	104 ft.	29 ft.	21 ft.	Dolomite	Beasley and Smith	20/12	Day and night.
104 ft.	134 ft.	30 ft.	23 ft.	,,	,, ,, ,,	21/12	,, ,, ,,
134 ft.	154 ft.	20 ft.	20 ft.	,,	Jones and Smith	22/12	,, ,, ,,
Total . .		79 ft.					

Date Set : Dec. 19, '30 Wt. 9·43 carats.
Date Cut out : Dec. 23, '30 Wt. 8·81 ,,
Setter's Signature : G. Tomlin Loss : 0·62

Remarks.—Heavy wear due to hard quartz stringers in hole No. 42 at 120 ft.

When carbons are broken or too small to set in regular bit, do not include them as carbon, but report them as loss (under " Remarks " ; state reasons in full for any excessive loss).

TABLE 3

DIAMOND DRILL HOLE REPORT

Drill Hole No. . . 25
Date Started . . Nov. 23, 1931
Date Completed . . Nov. 30, 1931

Ast. Bearing . . . N. 85. W.
Inclination . . . — 70°
Location of Collar. { Latitude . . 1004·39 / Departure . . 2430·6 / Elevation . . 486·03

From	To	Thickness	Description Formation	Class of Sample (Core or Sludge)	Assays Zn. %	Remarks
0	14 ft.	14 ft.	Loose ground with boulders	—	—	2½ in. casing taken to 14 ft.
14 ft.	20 ft.	6 ft.	Dolomite (Pink tinge).	—	—	
20 ft.	30 ft.	10 ft.	Dolomite.	—	—	
30 ft.	37 ft.	7 ft.	Broken dolomite.	—	—	6 in. cavity at 34 ft. 6 in.
37 ft.	42 ft.	5 ft.	Ore-body (Willemite and Iron Oxides).	Core.	43·2	
42 ft.	49 ft.	7 ft.	Ore-body (Willemite and specular iron.	,,	38·2	Broken ground.
49 ft.	56 ft.	7 ft.	Red schist, banded.	,,	2·1	
56 ft.	70 ft.	14 ft.	Grey banded schists, signs of pyrite.	,,	0·3	Lost water at 63 ft.
70 ft.	85 ft.	15 ft.	Blue schists.	,,	0·0	
85 ft.	120 ft.	35 ft.	Grey phyllites.	,,	0·0	
120 ft.	190 ft.	70 ft.	Banded phyllites, Fe in places.	,,	0·0	

78·2% of core recovered.

Engineer . . G. Tomkins.

TABLE 4

Total Footage Drilled . . .	10,700 ft.
Time taken for Drilling . .	9 months.
Average Depth of Holes . .	274·6 ft.
Deepest Hole . . .	719 ft.
Average Feet Drilled per Shift .	11·76 ft.
Average Petrol used per ft. Drilled	0·193 gals.
Average Percentage of Core Recovered	74·5%
Size of Core	15/16 in.

TABLE 5

	Cost per ft. Shillings	Drilled Dollars
DIRECT DRILLING COSTS		
Setter, runners, and helpers	4·67	1·135
Carbon loss . . .	1·45	0·352
Drill supplies . . .	0·70	0·170
Shop labour and repairs .	0·02	0·005
Lubricants and materials .	0·32	0·078
Power and fuel . . .	0·92	0·223
Moving drills . . .	0·02	0·005
Total Direct . .	8·10	1·968
INDIRECT DRILLING COSTS		
General expenses . .	1·45	0·352
Administration . . .	3·79	0·921
Surface	0·40	0·097
Assaying and equipment .	0·63	0·153
Core boxes . . .	0·25	0·061
Surveying . . .	0·04	0·010
Insurance . . .	0·23	0·056
Amortization of 50% drills	2·61	0·634
Total Indirect . .	9·40	2·284
TOTAL . .	17·50	4·252

as far as the author has been able to ascertain.

In Table 6 some comparisons between the two drills used are given. This shows that the Bravo drill with its smaller engine of 6 h.p. consumed more petrol than that of the larger drill. The deepest hole drilled by the Bravo 300 was 540 ft. deep, a vertical hole; this is considerably more than its rated capacity of 400 ft.

Fig. 6 represents a panoramic view of the open-cast at the Star mine, and around which considerable diamond drilling was done. This picture was taken from the south side of the open-cast near the centre and the camera swung over 260°; on it are marked

TABLE 6

Name of Drill.	Average ft. drilled per Shift.	Carbon loss per ft. drilled Shillings.	Gals. Petrol used per ft. Drilled.
BRAVO .	11·77	1·054	0·203
SULLIVAN 20	11·75	1·970	0·183

the drill-holes, dumps, and other items of interest nearby and if these are studied in conjunction with the plan (Fig. 7) it can be seen how useful photography can be made to demonstrate graphically to people far away, exactly how things are on the ground.

The I.M.M. Benevolent Fund

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

Central Mining-Rand Mines Group	£50	0s.	0d.
R. S. M. (Old Students) Association	50	0s.	0d.
W. Gardner	25	0s.	0d.
J. S. Watkins	25	0s.	0d.
J. H. Curle	20	0s.	0d.
Climax Rock Drill and Engineering Works, Ltd.	10	10s.	0d.
W. McDermott	10	10s.	0d.
C. F. Heathcote	10	0s.	0d.
E. D. McDermott	10	0s.	0d.
G. S. Duncan	5	5s.	0d.
S. W. Ford	5	5s.	0d.
A. A. Thomson	5	5s.	0d.
W. Cullen	4	4s.	0d.
Mining and Metallurgical Club (Derby Sweep)	3	15s.	0d.
S. Higham	3	3s.	0d.
E. A. Ashcroft	2	2s.	0d.
E. A. Baring-Gould	2	2s.	0d.
F. H. B. Claudet	2	2s.	0d.
A. Dickinson	2	2s.	0d.
Lord Skelmersdale	2	2s.	0d.
F. L. Teed	2	2s.	0d.
C. E. Parsons	2	0s.	0d.
C. O. Bannister	1	1s.	0d.
P. G. H. Boswell	1	1s.	0d.
C. Brackenbury	1	1s.	0d.
T. Breakell	1	1s.	0d.
J. Colquhoun	1	1s.	0d.
E. Halse	1	1s.	0d.
J. H. Ronaldson	1	1s.	0d.
W. J. Sutton	1	1s.	0d.
Previously acknowledged	166	13s.	0d.
Total	£427	10s.	0d.

BOOK REVIEWS

Witwatersrand Mining Practice. By G. A. Watermeyer and S. N. Hoffenberg. Cloth, octavo, 895 pages, illustrated. Price 45s. (South African). Johannesburg : Horters.

The outstanding fault of this monumental work, monumental both to the industry and ability of its authors, is its title. The general engineering and scientific matter, of which so much is included, is not Witwatersrand mining practice. On the other hand, the inclusion of this matter gives the book a far stronger appeal to the general reader, and particularly to the mining student.

History and geology of the Rand occupy the first pages and are followed by a brief chapter on prospecting. Breaking ground, shafts, shaft stations, and development occupy the next 216 pages, stoping and support the next hundred. Underground transport, winding machinery, and mine drainage and pumping complete the first 590 pages. Electric hoisting is hardly touched upon, whilst the treatment of haulage systems is scarcely less brief, and is really inadequate (Figs. 5 and 6 in this section are very poor). Many of the figures in other sections are indistinct because of the small scale adopted for reproduction. In the next chapter (82 pages) the principles and practice of mine ventilation are well and clearly set out. Sanitation, health, and labour occupy the next 146 pages. This section contains much of local as well as general interest, together with only ten pages on legislation and regulations. The next section (56 pages), that on mine surveying, is very disappointing. It is too short for the large number of subjects touched upon ; the most elementary material is closely interleaved with advanced principles in the form of apparently disjointed notes. It is interesting to see that the Wild theodolite is one of the three types illustrated.

The concluding sections, pp. 791 to 855, deal with mine sampling, economics and accounts. The treatment here is clearer and more logical, but, of necessity, too brief. Considering this book as a whole, it may be regarded as the most useful and comprehensive outline of mining practice published during the present century.

B. W. Holman.

Aus der Geschichte des österreichischen Eisenwesens. Die österreichisch-Alpine Montangesellschaft, 1881–1931. Cloth, quarto, 537 pages, illustrated, with maps. Price RM 21. Vienna : Julius Springer.

The Austrian Alpine Mining Company has celebrated the Jubilee of its fifty years existence by issuing a large volume in which its history is very fully described. Part 1 contains an account of the development of this company dealt with under the heads of its financial and commercial development, its technical and electro-chemical

development and the development of the social side, dealing with the various arrangements made for the care, comfort, and training of its workpeople. The second part contains the history of the various undertakings which are included in the operations of this vast company, namely the large number of coal (lignite) mines, the iron ore mines and smelting works, in which special attention is of course devoted to the great works at Donawitz, the magnesite mines at Wald, and quartz mines at Krieglach. Whilst the subject is of very little interest to anyone in this country, it must be admitted that the volume of some 725 pages is very well got up and is full of interesting details, showing the various difficulties with which this company has had to contend and how it has succeeded in overcoming them.

HENRY LOUIS.

Beiträge zur Geschichte des österreichischen Eisenwesens. Abt. I, 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. I, 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.

Simultaneously with the desire of the Austrian Alpine Mining Company to celebrate in some suitable way its half-century of existence, the managers of the Company decided to mark the occasion by a scientific work, which was to deal with the history of the iron industry in Styria and Carinthia from the oldest times up to the present. Ample material is available for this purpose, and it was decided to issue the work in five parts, for all of which a good deal had been done, when the unfavourable times decided the Mining Company to interrupt the printing for the time being. The result is that two volumes of Part I. and one volume of Part II, out of the proposed five Parts have now been published. The first treats of the geology of the Austrian iron ore deposits. The second is devoted to an account of Noric iron, whilst the third volume, Part II, deals with the political and economic basis upon which the Austrian iron industry has been founded. It is unnecessary to say that these volumes are tolerably complete and are of considerable historical importance, though probably of comparatively little interest to anyone in this country.

HENRY LOUIS.

Gems and Gem Minerals. By E. H. KRAUS and E. F. HOLDEN. Second edition. Cloth, octavo, 260 pages, illustrated. Price 18s. London: McGraw-Hill Publishing Co., Ltd.

The first edition of "Gems and Gem Minerals," by Professor Kraus and Dr. Holden, of the University of Michigan, published seven years ago, soon established itself as a source of reliable information to the mineralogist, to the lover of gems, and to the dealer, and it became a recognized standard work on this entrancing branch of mineralogy. In this second edition all chapters have been carefully revised, parts have been expanded, and in particular there is a great deal of additional information in the chapters dealing with the cutting and polishing of gems, and with manufactured gems. The number of illustrations has been increased by 69 and 38 pages have been added to the text. It is an excellent book.

WILLIAM R. JONES.

☞ 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

VANCOUVER

June 10.

Pioneer Gold.—The unexpected discovery of a new vein in the Pioneer mine is said to rank as "second to nothing" in the history of the mine. This vein was encountered in sinking the new vertical shaft, which penetrated it over a distance of 25 ft., at about the 1,600 ft. level. The strike and dip at the point of intersection indicate that the vein branches off the main vein and continues through virgin ground in the opposite direction. This ground was secured to the company by new locations quite recently. The new vein appears to be in all respects similar to the ore-body which is being developed so successfully,

having a width of from 3·5 to 5 ft., and carrying values in gold and silver. Two other smaller veins have been encountered also in some cross-cutting work from the upper levels of the mine, and altogether a considerably increased ore supply is indicated as a result of the development work in hand. Meanwhile the immediate objective of depth attainment is being approached steadily, when five new levels will be opened up for stoping operations to keep the new mill supplied. It is stated further that the capacity of the finished plant will be probably nearer 400 tons per day than 300 tons as estimated previously. In connexion with the future prospects the favourable character of the geological conditions was expressed by W. S. McCann, of the Geological Survey of Canada, in his report upon the area published in 1922.

Pioneer Extension.—At a meeting held recently in Vancouver the shareholders of the Home Oil Co. ratified the negotiations which had been initiated for the acquisition of the Pioneer Extension group of claims in the upper Cadwallader Creek valley, above the Pioneer mine. Reports have been received of the discovery of extensive bodies of gold-bearing quartz in this area, which are said to occur in the typical augite-diorite of the Cadwallader Creek camp. According to geological reports the intrusive rock peters out beyond the Pioneer ground into a narrow tongue, but it is claimed by prospectors and some others that such is not the case. The point is of particular significance, as although several quartz veins are known to occur in the sedimentary formations surrounding the augite-diorite and gold is found in some of these in places, the general character of these veins is distinct from that of the series of veins occupying fractures in the diorite, and the values are not of economic amount.

Bridge River.—Some valuable additions to the sum of knowledge of geological conditions in the Bridge River area are published in the report of W. E. Cockfield in the Summary Report of the Geological Survey for 1931. This information is of particular interest in the case of the Lorne mine. Dr. Cockfield was instructed last summer by the Director of the Survey to check up on certain facts that were brought to his notice by the Provincial Department of Mines, having a possible important bearing upon the economic value of the Lorne property. These facts were brought into prominence as a result of underground workings and were noted by the Resident Engineer of the Provincial Department, H. G. Nichols, who pointed out that owing to a previously unrecognized swing of the contact of the augite-diorite with the sedimentary formation, the Lorne vein system was to be recognized as being of the same general character as the Pioneer, inasmuch as both are marginal to the contact instead of being "transverse" and "parallel" respectively, as formerly described. With this interpretation there are certain definite possibilities in connexion with depth development upon the most important of the veins on the Lorne property. Dr. Cockfield endorses this view in his report and states that the contact of the diorite body swings to an easterly course in the vicinity of the Lorne mine and that a new significance is given to the local group of so-called "transverse veins" which may be considered to be in common with all the veins as belonging to one system which is marginal. He states further that a large part of the low-level drive on the Shaft vein, which has the most imposing outcrop of any on the property, lies in the sediments and that at some greater depth the vein may be expected to continue into the underlying augite-diorite, under which conditions the economic possibilities would be greatly enhanced. There are thus concrete possibilities of no small order in connexion with the active development of the Lorne mine, and it is to be regretted greatly that the company is so heavily over-capitalized as a result of the promotion activities in the boom days. Bralorne Mines, Ltd., holding a 60% interest in Lorne stock, is carrying on milling operations in the newly constructed plant and it is stated that satisfactory results are being obtained from the treatment of ore from the King vein.

Non-Metallic Mineral Resources.—A. M. Richmond, of the Provincial Department of Mines, has been conducting an investigation of the resources of non-metallic minerals and the results of his work are being published in a series of bulletins. The first two of this series have appeared already on the subjects of asbestos and barytes, and the general purpose of the publications is described in a foreword by J. D. Galloway, the Provincial Mineralogist. There are a great many occurrences of non-metallics in the province and some have been exploited successfully, notably the

deposits of gypsum at Falkland, which supply the raw material for a manufacturing plant at the coast, but, in general, expansion of this branch of the industry is dependent upon a greater demand and upon brighter industrial prospects than exist to-day.

Whitewater District.—United States Smelting and Refining Co. has relinquished the option that was held upon placer properties in the Cedar Creek area. This step was taken after examination by the company's engineer, who, it is understood, failed to get values as had been reported. The company had also made arrangements to do exploration work in the Whitewater district, north of Bridge River, where extensive zones of copper-gold mineralization occur in a granodiorite formation. This project has also been abandoned, although supplies for the work had already been forwarded. These latter properties were held under option by Consolidated Mining and Smelting Co., of Canada, Ltd., and a certain amount of work was carried out during two seasons, a few years ago. The results obtained at that time were not considered to be sufficiently encouraging and the option was dropped. The area is one of considerable promise, but is rather far from transport.

Atlin Lake.—At the recent annual meeting of the Atlin Ruffner Mines, Ltd., it was stated that ore reserves amounted to 104,000 tons of silver-lead ore with an appreciable gold content. The property of this company consisting of 24 claims is situated on Fourth of July Creek in the Atlin Lake area. It was originally known as the Big Canyon and Ruffner groups and was at one time under lease to the Federal Mining and Smelting Co. Mineralization consisting chiefly of lead, zinc, and iron sulphide occurs in zones of shattering in basic dykes traversing granitic rocks. Several veins have been prospected over a wide area of surface and a considerable amount of underground development has been done. Specimens of the ore carry high values in silver. Widths of vein matter up to 20 ft. are exposed in open-cut workings. Present development is being concentrated upon the driving of a cross-cut tunnel at an elevation of about 4,000 ft., which is expected to intersect the principal or No. 2 vein at a depth of about 1,000 ft. below its outcrop. It is understood that the financing of the work is being sponsored by Buffalo interests.

Nelson, Ymir, and Sheep Creek.—The gold-bearing area south of Kootenay Lake is the scene of a large amount of individual activity. This country includes the Nelson, Ymir, and Sheep Creek camps in which there are many mines that have been responsible for important production in past years. At the Perrier mine close to Nelson F. J. Sur has resumed operations after a temporary shut-down caused by flooding. Mr. Sur has also reopened the old Blackcock mine in the Ymir camp, where bodies of gold ore of a value of about $25·00 per ton are found in a quartz vein occupying a much-faulted fissure in schist. E. P. Crawford continues the shipment of ore from the Yankee Girl, and the Willcox mine in the same camp has been reopened by J. J. Cullinane, of Rossland. The last-named property has had a varied history, and was at one time, subsequent to the closing of the Ymir mine, the star producer of the camp. It is credited with a production valued at around $90,000. In the Sheep Creek area, O. C. Thompson, the managing director of Reno Gold Mines, Ltd., is personally superintending the remodelling of the Motherlode mill, recently acquired by his company for the treatment of the Reno ore, and the construction of the aerial ropeway. It is expected that production from the Reno mine will be resumed within the next two months. Meanwhile satisfactory developments are reported on the lowest or 5th level of the Reno mine and in view of the possible bearing that the discovery of primary ore of good grade on this property may have upon future possibilities in the camp generally, it is not surprising that attention is being given to several abandoned mines. A systematic examination is being made of the Queen mine workings and small shipments are reported to have been made from the adjoining Vancouver claim.

Kamloops.—D. B. Sterrett, formerly of the United States Geological Survey, who has been opening up a series of gold-quartz veins in an isolated area of greenstone around Vidette lake, north of Kamloops lake, has completed arrangements for the treatment of the ore and milling is to be commenced with a view to assisting in the further development of the property. Three veins have been exposed in surface workings and an incline shaft has been sunk on one of them to a depth of 65 ft. Mr. Sterrett believes that an amount of ore calculated

to have a gross value of about $80,000 may be reasonably expected as a result of the work that has been done so far, and is hopeful of proving a much greater tonnage. The veins are narrow, varying between 5 in. and 15 in., but the values as indicated by systematic sampling are remarkably uniform around $30·00 per ton.

Oil in the Okanagan Valley.—A second warning as to the inadvisability of spending money in an attempt to find oil in the Okanagan valley has been given by C. E. Cairnes, of the Geological Survey. Dr. Cairnes wrote an article upon this subject two years ago which was released for publication in the Press, and the opinions then expressed are confirmed in the Summary Report of the Survey that has just been published. In spite of these warnings, a well has been sunk to a depth of over 2,000 ft., and at the present time more capital is being subscribed for the purpose of casing it, on the strength of " indications " obtained. Dr. Cairnes states specifically that there is no chance of finding either petroleum or natural gas in appreciable amount in this field.

Boundary.—In the Boundary country, Hecla Mining Co. is continuing the development of the Union mine in the Franklin camp, but no further occurrences of the exceptionally high-grade gold ore have been found. Diamond-drilling work is also being done on the adjoining Maple Leaf claim and the driving of a cross-cut tunnel to reach the limits of the pyroxenite formation is said to be contemplated. The old Carmi mine in the Beaverdell area has been acquired by a party of operators of Midway with the intention of making use of the facilities thus provided for the further development of the Butcher Boy property that adjoins it. The Butcher Boy vein carries some high values in gold, but is thought to belong to the same general system as the Wallace Mountain silver-lead veins, although at a lower horizon; it has been partially developed from an 80 ft. shaft. Shipments of high-grade silver-lead ore are still being made from the Wallace Mountain properties and Angus Davis, who is in charge of the development of the Beaver silver mine, adjoining the famous Bell property, reports good progress in the development work. The Oro Fino mine near Olalla, where there is a big quartz vein, with occasional shoots of ore with free gold, has been reopened.

TORONTO

June 18.

Porcupine.—The output of bullion of the producing mines of the Porcupine area during April was valued at $1,624,241 from the treatment of 272,380 tons of ore as compared with $1,222,986 from the treatment of 259,218 tons for the preceding month. Dome Mines during May produced bullion to the amount of $411,201, as compared with $354,254 for April, and $300,390 for May of last year. The sharp gain in production for May was almost entirely due to the gold produced from the rich high-grade pocket located on the 13th level, which has yielded approximately $50,000 in gold. Mill heads are stated to have exceeded $9 per ton, as compared with the average for the year 1931 of $6·42 per ton. The annual report for the McIntyre Porcupine for the year ending March 31 shows earnings of $5,365,521, as compared with $4,633,323 for the previous year. The operating profit before providing for taxes and depreciation amounted to $2,491,496, as compared with $2,086,048. The ore reserves at the close of the year were estimated at $19,859,863, as against $20,480,964. During the year 655,030 tons of ore were treated of an average grade of $8 per ton with a recovery of $7·63 per ton. For the purpose of increasing underground development additional air-compressor capacity is being provided. The Coniaurum is preparing to operate on an increased scale. A new compressor has been installed and a number of new machines have been added for underground development. The mill is operating about 50% which is approximately its limit with existing hoisting equipment. Mine development is making steady progress and the lower workings are producing better values than those obtained above. The mill of the Ankerite which resumed operations about two months ago is treating about 200 tons of ore a day and operations are stated to show a profit. Extensive development is in progress. At the present time work is proceeding along the diabase dyke, at which point previous operators believed the mineral zone terminated and operations are bringing to light good values in gold, the average grade being stated to run better than $10 to the ton. The March mine adjoining has suspended operations. A rush of prospectors has taken place to the area north-east of Night Hawk Lake, and east of the producing

gold belt of the Porcupine camp. This area attracted the attention of prospectors some years ago and many claims were taken up but abandoned before being thoroughly tested. So far about 400 claims have been staked, and many prospectors are hastening to the district.

Kirkland Lake.—During April the Kirkland Lake mines handled 146,095 tons of ore which yielded bullion to the value of $2,043,055, the tonnage handled during March being 152,445 tons with an output of $1,897,517. The mill of the Lake Shore is treating about 2,400 tons of ore per day with a recovery of $14·80 per ton. Development work is being aggressively pushed and is meeting with good results. The No. 3 shaft which has as its objective 4,000 ft. depth has reached a depth of 3,600 ft. On the various levels down to 2,950 ft. large sections of high-grade ore have been opened up, while on the horizons from 2,200 ft. to the bottom level the ore zones have widened out considerably. Teck-Hughes is showing improvement both in production and in mine development. The mill is handling 1,300 tons of ore daily with mill heads averaging about $15. The 34th and 35th levels are receiving special attention and are responding well to development. While work is not yet sufficiently advanced on these levels to give a definite average of width or value, they are reported to show improvement from the levels above. Some of the ore is going to the mill from these levels, resulting in an increased recovery. Development work at Wright-Hargreaves is making steady progress. The new central shaft which is being put down to a depth of 4,000 ft. has already reached a depth of about 1,600 ft. The mill is treating some 800 tons a day, with mill heads of more than $12 per ton. On the two bottom levels—2,850 and 3,000 ft.—the North vein has been opened up for 500 ft. and shows gold content of nearly $30 to the ton. Values however are much lower on the South vein, where considerable work has been done. The annual report of the Sylvanite for the year ending March 31 shows an income of $979,973 and a net profit of $280,092. The total tonnage treated was 94,276 tons, with an average recovery of $10·07 per ton. Special attention has been directed to opening up the 2,500- and 3,000-ft. levels; a cross-cut on the former horizon has picked up the South vein which carries gold values of $10 over a width of 5 ft. The Kirkland Lake gold mine is proceeding with its deep development programme at the 4,950-ft. level. High-grade ore has been encountered in cross-cutting, but further work will be necessary to determine the full possibilities of this horizon. At the Macassa the shaft has reached a depth of 2,150 ft. The drive in from the Kirkland Lake adjoining has proceeded for a distance of about 2,200 ft. and throughout the greater part of this distance has been in ore ranging in value from a few cents to $50 in gold per ton, with an average of about $13. Kirkland Gold Belt mines, adjoining Bidgood in the eastern section of the camp, is meeting with good success in development and is opening up good ore on the 125-ft. level.

Other Ontario Gold Mines.—The Parkhill in the Michipicoten area is maintaining a steady production rate with the mill treating between 50 and 55 tons a day, the mill heads averaging $15 per ton. The company is carrying on an extensive programme of underground development with levels down to 480 ft., the ore showing improvement in width and grade at depth. The success of the Parkhill has stimulated work by other companies in this field. Good progress is reported in connexion with the mine development at Ashley Gold Mines in the Matachewan district. An important strike of high-grade ore has been made on the 150-ft. level. Good ore is being opened up on all levels down to 500 ft. A mill is under construction and is expected to be in operation before the winter.

Sudbury.—The smelter and refinery of the Falconbridge Nickel mines are operating at full capacity notwithstanding which its surplus stock of nickel is being steadily reduced. This is due to the extensive contract for nickel obtained by the company some time ago in the United States. The President recently stated that the entire output of the company had been contracted for several months ahead, and if new business continued in the same proportion it would be necessary to increase the capacity of their smelter. At the mine general conditions show little or no change, and as there is sufficient ore in sight to supply the mill for some time to come no effort is being made to carry on exploration on a large scale.

Rouyn and North-Western Quebec.—The Siscoe Gold Mine produced bullion in May to the value of approximately $77,800, the average recovery being about $14·30

per ton. The value of production for the first five months of the year is $480,000, of which approximately $260,000 is estimated as profits. Results of development work at the 600-ft. level have been highly encouraging. The shaft is approaching its objective of 1,000 ft., and three new levels are ready for opening up. The question of enlarging mill facilities is being considered by the management. At the Granada the new cyanide unit of the mill has been put into operation and is running satisfactorily. The mill is operating at approximately 100 tons of ore per day with a recovery of over $14 per ton. New veins have been discovered in the lower workings down to 1,000 ft. and the average ore grade below the 600-ft. level is considerably higher in gold content than that found in the upper horizons. The results of explorations by diamond drilling on the Sullivan adjoining the Siscoe mine have been encouraging and the management have ordered a mining plant and will undertake active development. Cross-cutting will be started on the 250-ft. level to reach the ore zone indicated by diamond drilling. Hollinger Consolidated has acquired a group of claims in the Pascalis district on which preliminary exploration has revealed promising surface showings and a diamond drilling campaign is to be carried out. The Connell Mining and Exploration Company owns 20 claims in the Pascalis area on which several important discoveries have been made showing high gold values. An extensive development programme will be carried on throughout the summer. The Pandora is obtaining good results from driving on the 250-ft. level, where the vein shows an average width of 11 ft. carrying good quantities of free gold.

Manitoba.—Reports to the effect that the Hudson Bay Mining and Smelting Company had suspended operations at the Flin Flon or were preparing to do so were positively denied by President R. H. Channing, who stated that the directors had no intention of shutting down. It is understood that notwithstanding the low price of copper the production of gold enables the company to continue work with an operating profit. The new mill of the San Antonio Mines in Central Manitoba, which has a capacity of 150 tons daily, is operating smoothly treating about 75 tons of ore a day. There are 60,000 tons of ore now available for mill feed, and the ore reserves are being steadily increased. Mine development is showing good results and ore stated to average about $12 per ton is being opened up. The Cryderman Mines, Ltd., has a 50-ton mill in operation on its property in the Rice Lake district and has made its first shipment of gold. The Oro Grande Development Company is reopening its property located about 2 miles east of Central Manitoba Mines. Ore in sight carries high gold content and a 25-ton mill will shortly be installed.

JOHANNESBURG

June 2.

Sabie District.—In connexion with the revival of gold digging activities in the Sabie district, Northern Transvaal, it is stated that on the farm Ceylon recently the demand for claims was such as to induce the mining commissioner to decide ownership by what may be termed the "Grasfontein method," that is by peggers running for claims. Large areas of the farm have been pegged including the creeks on Mount Anderson, and active digging is proceeding. It is difficult to get accurate information, but a considerable body of overburden has in some instances to be handled before rock-bottom can be reached and these claims are thus more in the nature of expensive mining propositions. Mount Anderson, which is 9,000 ft. high and the highest peak in the Transvaal, has in the past yielded much wealth from its creeks, in fact, some 27 years ago one family is alleged to have recovered some £50,000 in gold and to-day the same creek is pegged and being sluiced high up the mountain with fair results. Water in this fortunate district is abundant and the spruits are running strong to-day. The constant precipitation of mist on the mountain accounts for this enviable condition.

Swaziland.—It is reported that satisfactory results have been obtained by prospectors who pegged claims during the recent rush in the Forbes Reef concession in Swaziland. A well-defined reef giving good panning results has been obtained by one party who are investigating a large area of ground that is held by a Johannesburg syndicate. The presence of alluvial gold which, in places, gives highly payable values, is also reported from the same area. The Makwana Tins concession covering some 10,000 morgen and containing alluvial tin and gold has also been taken up. This ground lies upon the Swaziland side of the

Transvaal-Swaziland boundary along the Oshoek fence and extends over a wide flat, beginning upon the northern side at the southern boundary of the Forbes concession and continuing southwards to the neighbourhood of that well-known landmark, the Makwana Kop. On its eastern side is a concession commonly known as Kelley's, owing to the fact that the late Mr. James H. Kelley was largely interested in it. Upon the western side of the Transvaal-Swaziland boundary, which marks the limits of the Forbes concession on that side, lie the farms included in what is commonly known as the Steynsdorp goldfield. A Capetown syndicate has been engaged in sluicing for alluvial gold in this neighbourhood for some months past, but a contemplated flotation upon a larger scale has not yet been effected.

Simmer and Jack.—At the annual meeting of the Simmer and Jack Mines, the chairman (Mr. W. A. Mackenzie) gave some interesting and encouraging figures regarding the results disclosed in the pyritic area in the central portion of the mine between the Rhodes and Milner incline shafts. Up to March 31 last a total of 2,170 ft. had been sampled, of which 1,310 ft. proved payable at an average value of 9·1 dwt. over a stoping width of 61 in. It was stated that a full-time geologist, under the supervision of Dr. L. Reinecke, has been engaged to make a study of the deposit at the mine and its relation to similar occurrences in other parts of the Witwatersrand.

Geological Survey.—Dr. A. W. Rogers has retired from the post of Director of Geological Survey. During his term of office as Director, great strides were made in ascertaining the extent of the mineral wealth of South Africa. Dr. Rogers came to South Africa in 1896 to join the Geological Commission of the Cape, of which he later became Director. At Union he became Assistant Director of Geological Survey, and was appointed Director in 1915. His successor has not yet been appointed.

IPOH

June 10.

Tin Sales and Restriction.—The news received here early on June 7 of the temporary suspension of the London tin market, and the reasons for that action, has made a grave impression and tends to nullify or at least to minimize any strengthening and hopeful effects that might result from the decision by a majority of the open-cast miners to support the amended scheme for further drastic limitation of output. On that day there was no tin market in Singapore, and Chinese miners who wanted to sell ore found they could not get a quotation from the smelting companies and consequently could not put themselves in funds for the Chinese festival due the following day. The only other occasion in the last 25 years when no market for tin in Singapore has been announced was on the declaration of war in 1914. On the same date there was a meeting of Perak Chinese miners in Ipoh, which was attended also by the Warden of Mines, Perak, and by Mr. T. R. A. Windeatt, the latter of whom explained the modified scheme under which open-cast mines would be dealt with under three categories by which differentiation it is proposed to meet the necessities of producers in different circumstances. The High Commissioner sent a message by telegraph to the Warden of Mines expressing his hope that the Chinese producers would support this new scheme, adoption of which he considered would be in the best interests of the whole mining industry of Malaya. This meeting decided by a large majority in favour of supporting the modified scheme which covers a period of twelve months from the end of the current month. Under this scheme miners in category (B), who do not entirely suspend production during July and August, are to be limited to 25% of their quotas for a defined period of 12 months from July 1, and those who suspend production during July and August (Category A) will be granted quarterly quotas to produce and export 30% of their assessment for the following 10 months. By this arrangement producers in both categories will have the right to the same total production during the year from July 1. In a third category (C) provision is made, for Chinese mines only, which may elect to produce and export 27½% of their assessments during the same period of twelve months, and in their case the 2½% excess over the quota permitted to mines in category (B) will be adjusted by deduction when quotas are eventually increased.

A feature of the discussions and correspondence on the subject of the need for more drastic restriction has been that European and Chinese producers have been often referred to as if only Chinese miners were producing from open-cast mines, which

ajority of it would be expensive to keep pumped out
the amend in good working order during a two
limitation months' stoppage of production. But there
no tin are well known examples of European-
ers who owned mines of this type, such as Sungei
could not Besi mine in Selangor, and the Idris
lting com Hydraulic and Lahat Mines in Perak. The
put them Pahang Consolidated Company's mines in
festival of Pahang would be even more adversely
other occ affected by complete stoppage of output.
o market in every possible facility for "grouping"
ounced wa will be granted to all mines holding
1914. On th certificates of Production. These facilities,
ing of Perak however, are not intended to be used in
was attended such ways as would cause discharge of labour,
nes, Perak, but only so that labour and plant may be
att, the latter employed to the best economic advantage.
ed scheme under **Labour.**—The reduction of quotas from
ld be dealt wit 0% to 33⅓% of assessment, which took
which differenti fect from the beginning of June, has
eet the necess sulted in some discharge of labour and
ent circumstance nsequent repatriation of Chinese, but the
r sent a messa mber claiming repatriation has been much
arden of Mines ex eater than would result from discharge of
Chinese producers ine labour. A false report was spread in
cheme, adoption o erak to the effect that any Chinese applying
d be in the best in the Protector of Chinese, Perak, would be
ing industry of patriated at the expense of the F.M.S.
ded by a large m overnment, with the result that suddenly
ring the modified ndreds of men and women, not a few of
eriod of twelve m om were of the "squatter" or market
e current month. rdener classes, swarmed round the
in category (B), otectorate offices every day. Notices
end production ve now been issued to the effect that
are to be limited patriation is confined to men unfit to work
for a defined pe d to those able to show proof that they
July 1, and th both unemployed and destitute. A free
during July an p to China at Government expense would
be granted ve obvious attractions for many Chinese,
and export 30% pecially as few have any idea of the
e following sperate condition of large numbers of the
ment producers pulation in that country. In the neighbour-
the right to the od of all centres of population there are
the year fro vays many "squatters" (occupiers of
(C) provision te or other land to which they have no
only, which m le, but pay a small annual licence fee or
ort 27½% c to the Government for cultivating
same period ound). In mining districts they help to
r case the 2 p local foodstuffs cheap and plentiful,
ed to mines d form a reserve of casual labour for all
by deductio ts of mining, estate and public works.
creased. e loss of many of these people through any
issions and stake would be bad business for them and
of the ne this country even as things are at
has been sent.
ucers have **Decentralization.**—There has been an
Chinese m icial announcement that the Secretary of
t mines, wi te for the Colonies proposes to send Sir Samuel Wilson, Permanent Under-Secretary of State for the Colonies, to Malaya for the purpose of discussing with the High Commissioner, the Rulers, and others the proposals to decentralize certain public services. Sir Samuel cannot leave for Malaya before the end of September, on account of the absence of the Secretary of State at Ottawa. It is evident from this announcement that the home authorities have realized the gravity of the changes proposed. Even if the headquarters of such an important branch of the public services as the Mines Department were to remain in the Federated Malay States the useful influence of its presumably well-informed chiefs would be minimized if they were not in sufficiently close communication with the heads of the administration in these States.

KALGOORLIE

May 20.

Wiluna Developments.—Apart from the value of its increased gold output, the greatest uplift the mining industry of this State has had recently is the discovery and development of an entirely new lode on the Wiluna gold mine, officially termed the No. 2 West Lode. The fact that an ore-body at least 1,000 ft. in length, in places 50 ft. in width and of a payable grade, is ready to be developed from the grass roots to the 700-ft. level, shows what possibilities there are not only on the Wiluna field but in others when the services of a high-class mining geologist can be employed, and funds made available to carry out his recommendations.

Lake View and Star.—Similar satisfactory results have been attained on the Lake View and Star at Kalgoorlie, where a number of shoots of ore hitherto unknown have been discovered by boring, as the result of scientific study of the ore-bodies. The task undertaken by this company to prepare to mine and treat 30,000 tons a month from old mines was indeed a big one. It is gradually approaching that figure. In April 23,555 tons of Company's ore and 4,949 tons from the tributers totalling 28,504 tons show that the mill is almost up to the capacity asked for. When the last wet crushing unit is in commission there will not be any difficulty in treating the tonnage. Development is being pushed on, and as the tributers drop out the mine tonnage will increase. This will be made more possible

when the Chaffers main hauling shaft is ready. This is being cut down to take a greatly increased tonnage. Meantime the Ivanhoe and Horseshoe No. 2 Shafts have had to cope with the quota already reached. Quite a remarkable achievement, considering the size of these shafts. Not only has the successful development and extraction of this tonnage been accomplished, but by improving the grinding section and floating all of the sulphide and telluride ore, costs have been materially reduced, as the result of which a grade several pennyweights per ton lower can be successfully treated, than it could have been in the past, thus greatly increasing the potential ore supplies of this company.

Boulder Perseverance.—The Boulder Perseverance has its new additions to the plant nearly completed, whereby roasting will be eliminated and the gold solution effected by bromocyanide, which with new conditions and a greater knowledge of the reactions and their effect, costs are expected to make it a competitor with froth flotation for Kalgoorlie ores.

Developments at Other Properties.—Other mines at Kalgoorlie have by these successes been heartened to carry out prospecting development work, notably the Great Boulder and North Kalgoorlie, with encouraging results in the opening up of new ore shoots. The advent of the Broken Hill Proprietary in its search for gold mines in this State has shown the possibilities that are expected to exist. The opening up of the Hamans North at the north end of the field by this company after years of idleness may mean much. The option on the Enterprise group of leases will mean the testing of the deeper ground to the west of the North and South Kalgoorlie mines. The search for options on promising properties throughout the State by this company has given an incentive to many prospectors to look for suitable mines to be developed. The sinking of the main shaft on the Sons of Gwalia following on the very successful development of its main and new ore-bodies will mean many years more life to this mainstay of the northern field. Work has recently been started to test the Lancefield ore-body by boring at greater depth. If successful capital will be available to reopen this mine, which had a fine record at a time when the treatment of refractory sulphide ore was not known so well as it is to-day.

Less-Known Fields.—On the Broad Arrow field a number of smaller prospecting syndicates are at work with varying success, the best being obtained in the Ora Banda portion of the field, where a State battery has been crushing almost continuously for months, and the results obtained nearly all go back to prospecting and development. The same may be said of the Meekatharra field, although here the Ingliston Consols has been a steady producer for many years. The premium and exchange have enabled it to treat 5-dwt. ore at a profit. There are many smaller shows in the vicinity—at the Magnet, Nalgoo, and further north at Peak Hill and Nannine, where prospectors are making a good living. On the Yilgarn field, from Glenelg Hills in the south up to Southern Cross, there are several public crushing plants, dealing with ore of good grade of picked material. At Westoma the Princess Royal is the only company at work. Development is proceeding below the No. 3 level, with satisfactory results, and with a gradually growing reserve of profit from ore won. Further north near Bullfinch there are a number of prospectors, and at Golden Valley the Radio and Radio Deep mines produce a very handsome profit for their owners.

Prospecting.—Despite the dryness of the past summer, more prospectors have been out this year than for many years past. Although no new finds of any importance have been made, many old miners who have been driven off their farms owing to the fall in the price of wheat have been able to earn a living. Thus the prospects of mining for gold in this State help to mitigate the losses in the other primary industries, wheat and wool.

BRISBANE

May 23.

Mount Isa.—Operations at the mine and smelter on the Mount Isa field, according to official reports, continued to run smoothly during April. Good progress was being made with the erection of the new plant and the original Dwight-Lloyd furnaces were being improved so as to bring them into line with the new ones in course of erection. In underground work the seven glory-holes on the Black Star lode have again been continuously operated and the same is said regarding the shrinkage stopes on the main lode at the No. 4 level in the Black

Rock section. In the latter section, too, in the same level, the G40 winze, which is being sunk to connect with the H40 rise from the No. 4 level, was advanced during the month to 86 ft. At 35 ft. the H50 winze connected with the I51 rise, and the main lode stope at the No. 4 level is being extended south on the 25-ft. south level. The foot-wall at the G40 north and south level holed through to the G42 cross-cut, and lateral development is now in progress. The G42 west cross-cut has been completed, and the G38 cross-cut begun towards the lode. Further work below the surface has been the completion, in the Rio Grande section, of the drawing of the main lode stope at the No. 4 level and the continuous stoping operations on the middle lode. At the No. 4 level in the same section the foot-wall south of the No. 1 hanging-wall stopes were worked without interruption. Also, the development of the pyrite lode was continued to the north and south. Diamond drilling has been continued both from the surface and from underground. The No. 2 Crystalena bore-hole has been completed at 334 ft., and the plant removed to the Crystal leases immediately to the south of the Lawlor shaft. The Crystal No. 1 bore-hole was at the end of April down 181 ft. In underground drilling the No. 51 east bore-hole from the No. 3 intermediate level on the Black Rock lode, which was used to test a faulted section, has been finished.

Mount Isa Coke.—The Queensland Government has decided that the coke ovens to be erected for the manufacture of coke for the Mount Isa Company shall be placed at Bowen, which is the next port south of Townsville and about 700 miles by rail from Mount Isa. The people at Collinsville, Bowen coalfield, which is 50 miles from Bowen, were expecting the ovens to be placed at the State mine on that field, but the port of Bowen has been chosen as the more suitable, the chief factor in its favour being convenience and economy in the handling of the fuel and electric power supplies. The estimated cost of the coke ovens ($50,000) has already been voted by Parliament and work on them is to be started immediately. Besides for the Mount Isa mines, coke will be available for the Chillagoe State smelters, and for other purposes in North Queensland. It is reckoned that from 20,000 to 30,000 tons of the fuel will be required annually.

Mount Wandoo Mine.—At the newly discovered gold mine at Mount Wandoo, in North Queensland, development work has been continued since the lessee, Mr. Alex Macdonald, left for England, but no crushing has been reported. According to reports supplied to the district mining warden, there were in April eighteen men employed underground and twenty-seven on the surface, but, on account of the shortage of water hampering the surface work and the installation of more machinery at the mine, it was intended temporarily to reduce the number of employees to twelve. At latest reports the main shaft was down 130 ft., and levels are being driven east and west from that point. Both drives are stated to be still in ore of high value. A cross-cut, which has also been pushed in from the bottom of the shaft, has intersected three definite ore-bodies in a distance of 21 ft. from the bottom, and it is stated that further ore channels seem likely to be encountered. The intervening "bone" between the ore channels varies in value from 1½ dwt. to over 1 oz., and the management hopes to be able to stope a width of 20 ft. carrying high values. A quantity of about 2,000 tons of ore is available for the battery, but owing to the scarcity of water, milling operations seem likely to be delayed.

Cloncurry Copper Mining.—In the Cloncurry district, in north-west Queensland, work has been resumed at the three Mount Elliott mines—Mount Oxide, Dobbyn, and Orphan—which had been held up for some months by a strike and which are in the hands of tributers. The privately owned Trekelano, which had, owing to the low price of copper, also been shut down for some time, has resumed operations, and last month sent 560 tons of ore to the Chillagoe smelters. At the Mount Oxide ore extraction has begun and repairs are being made to the 80 miles of road over which the ore from this mine is conveyed to the railhead at Dobbyn. In the Dobbyn mine a lode in the south shaft is being exploited and is showing a development of 4 ft. of rich ore, while in the north shaft development is taking place on ore of a satisfactory grade about 1 ft. in width.

Mount Morgan.—Another definite move is on foot to again work the once famous Mount Morgan mine on a large scale. The proposal now is to spend on this mine a portion of a sum of £620,000 which the

Federal Government is making available in this State for unemployment relief. Mr. W. N. Gepp, formerly chairman of the Migration and Development Committee, has been commissioned by the Federal Government to report on the scheme. He has already visited the mine and his report is expected within a week or so. It has been proved by diamond drilling and assaying that there are 700,000 tons of payable ore in the mine, and the general manager of the new Mount Morgan Company (Mr. A. A. Boyd) has asserted that, without any direct Government assistance, but with a guarantee to the bank of £35,000, he could start in immediate employment from 200 to 300 men.

PERSONAL

JOHN A. ALLAN has been elected president of the Canadian Institute of Mining and Metallurgy.

PERCY ASHMORE has returned from West Africa.

H. BRERETON BAKER is retiring from his position as Director of the Chemistry Department of the Imperial College and from the chair of that faculty in the University of London.

CHARLES A. BANKS is here from New Guinea.

WALTER BROADBRIDGE is home from West Africa.

P. C. DELAITRE is returning to French Equatorial Africa from Paris.

W. P. FOULKES is home from Chile.

W. A. HARDY is returning from India.

PRESTON LOCKE has returned from West Africa.

C. E. E. PARGETER is returning from Uganda.

GEORGE C. RILEY has returned to Canada.

ALEXANDER RODGER is returning from Spain.

J. G. ROSS is here from Canada.

J. H. SOUTHWOOD is returning from Sierra Leone.

D. A. THOMPSON is returning shortly to West Africa.

W. E. THORNE has returned from Colombia.

G. W. EATON TURNER is home from the Gold Coast.

J. G. WALLWORK has left for British Guiana.

A. B. WATSON is home from Nigeria.

W. J. WILSON is returning from Nigeria.

H. W. YATES is home from France.

RICHARD DAVEY, who died on June 11, was an experienced metallurgist, especially in the treatment of certain complex ores of copper, lead, zinc, tin, etc. His early work was in France, later in South Wales and Italy, and his consulting work took him to Germany, Sweden, Russia, and Northern Rhodesia.

JOHN WALTER GREGORY met with his death, early in June, at the age of 68, by drowning in the rapids of Pongo de Mainique, on the River Urubamba, where he was carrying out geological research on the Amazon basin. Dr. Gregory was, at the time of his death, Emeritus Professor of Geology in the University of Glasgow, having from 1904 to 1929 been Professor. Prior to this he was in the chair of that faculty at Melbourne for four years, during part of which time he was Director of the Geological Survey, Victoria. Elected F.R.S. in 1901, Professor Gregory was a D.Sc. of London and Melbourne and LL.D. of Liverpool, and a past President of the Geological Society, of which he had been awarded both the Bigsby Medal (1905) and the Lyell Fund (1892). He was a recognized authority on mineral deposits, notably those of copper and gold, and was one of the first to maintain the placer theory of the origin of the gold mines of the Witwatersrand. He will probably be best remembered for his work in the great rift valleys in East Africa, although his fame as an explorer and antiquarian is equally world wide. He had travelled extensively, not only in East Africa but in North America, Australia, Tibet, and in the Antarctic.

TRADE PARAGRAPHS

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for June have an article describing with several illustrations their centrifugal vibrating screens, which were mentioned in these columns in April last.

Denver Equipment Co., of 1419, 17th Street, Denver, Colorado, have issued leaflets drawing attention to their units for placer gold concentration, to their Sub-A flotation machines, Sub-A flotation cleaners, and an automatic sampler for wet or dry material.

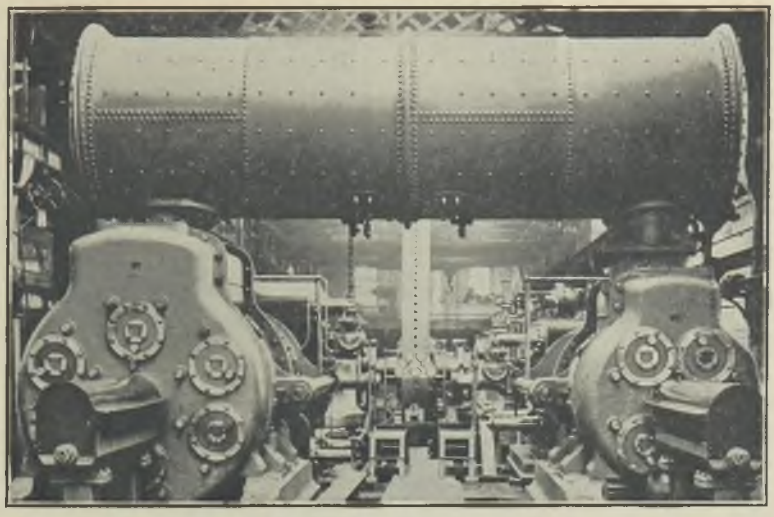
Bureau of Information on Nickel of the Mond Nickel Company, Ltd., of Thames House, London, S.W. 1, publish a leaflet on the subject of spades and shovels manufactured from nickel-chromium steel, which gives particulars of these implements as made by **Hardypick, Ltd.,** of Sheffield.

General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2, in the *G.E.C. Journal* for May have an article describing the electrical equipment and mining plant at **Mount Isa Mines,** which includes reference to electrical plant of their manufacture and mechanical plant made by Fraser and Chalmers Engineering Works.

Hadfields, Ltd., of East Hecla Works, Sheffield, was visited by members of the Institution of Mining Engineers on the occasion of the Summer meeting in Sheffield last month. It is not necessary to describe here what the visitors saw since the works have already been described in these columns, notably in the issue of June, 1927. All the Hadfields mining specialities were brought to the notice of the visitors, particularly, of course, those of interest to colliery engineers.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following orders:—For England: One 3 in. by 28 in. Hardinge pebble mill for unnamed duty, and one 3-roller "Baby" Raymond mill for flowers of sulphur. For France: One 4-roller Raymond mill for barytes, one 3-roller Raymond mill with heavy rolls for barytes, and one No. 00 Raymond pulverizer. For Spain: Three 2 in. "Grit" pumps for gold. For Finland: One No. 1 Raymond pulverizer for lime.

Svenska Export Aktiebolaget, of Stockholm, Sweden (London Representatives: **Scott and Strutt, Ltd.,** of 25, Victoria Street, S.W. 1), have issued a booklet giving some information about hollow mining drill steel. This, after discussing the common causes of breakage of drill-steel resulting from cracks formed in the core and spreading, proceeds to indicate the essential advantages of their Swebo steel. This it is claimed is unequalled



NEW AIR-COMPRESSOR FOR DAGGAFONTEIN MINES.

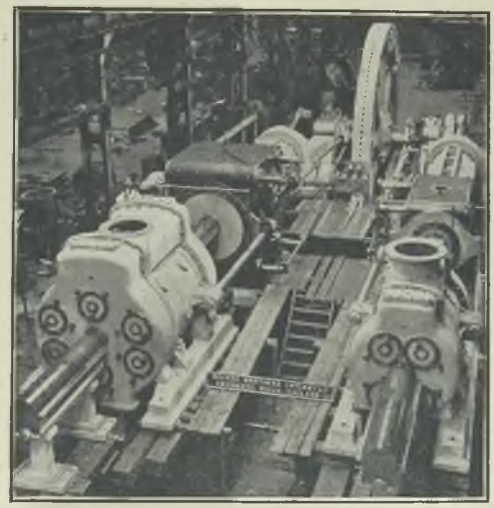
in that it is rolled on a hollow core and that the core may be made of non-corrosive steel or of pure charcoal iron, according to whether or not the mine water is corrosive.

Petters, Ltd., of Yeovil, during the week May 30 to June 4 opened their works to receive visits from a number of users of power for industrial and other purposes. The following are among the principal manufactures of the firm of interest to readers of the MAGAZINE, which were exhibited to the visitors:—Atomic Diesel cold-starting oil engines in sizes from 7 to 400 b.h.p. in one to six cylinders. Surface-ignition medium-compression oil engines from 5 to 36 b.h.p., M type oil and petrol engines in sizes of 1, 2, 3, and 5 b.h.p., and air-cooled petrol engines of 2 and 4 h.p. for duty such as driving electrical generators or centrifugal pumps.

Vacuum Oil Company, Ltd., of Caxton House, London, S.W. 1, have published No. 7 of their Gargoyle Technical Series, which deals with wire ropes, their care and treatment. After discussing the manufacture of the rope and various types of oil employed the work leads up to the lubrication of the rope, its object, the method of application of lubricants, and the essentials of a correct lubricant for the purpose. This work is illustrated with photographs of mine headgear and diagrams of methods for the continuous lubrication of steel wire rope and has brief particulars of the different classes of ropes for such purposes as winding, haulage, casing lines for oil wells, etc.

Ruston and Hornsby, Ltd., of Lincoln, in a leaflet which they are issuing emphasize the fact that the title Diesel engine is being widely applied incorrectly. They point out that the Diesel engine is that which receives its fuel by means of compressed-air pump whereas the Ruston oil engine, as also a number of other heavy-oil engines, are airless injection engines and are developments of the original Akroyd-Stuart patents dating from 1890. These patent rights were taken over by Hornsbys who originally manufactured the Hornsby-Akroyd engines. In other words the airless injection engine is definitely British in origin and the name Diesel should not really be applied to it.

Walker Brothers (Wigan), Ltd., of Pagefield Iron Works, Wigan, have supplied additional information concerning the two air-compressors they recently built for Daggafontein Mines, to which some reference was made in the article on that property in the May issue of the MAGAZINE. One of the installations is illustrated in the photographs on this page and the following are brief particulars:—The set has a free-air capacity of 10,000 cu. ft., delivering on a final pressure of 85 lb. per sq. in. with a steam pressure of 140 lb. per sq. in., although the engines are sufficiently strong to withstand 160 lb., which will be the increased pressure when running at a speed of 84 r.p.m. The engines are the horizontal compound steam two-stage air-compressing type, having high pressure steam cylinders 28 in. diameter and low pressure of 56 in. with corresponding air cylinders of 32 in., and 53 in. by 4 ft. 6 in. stroke respectively.

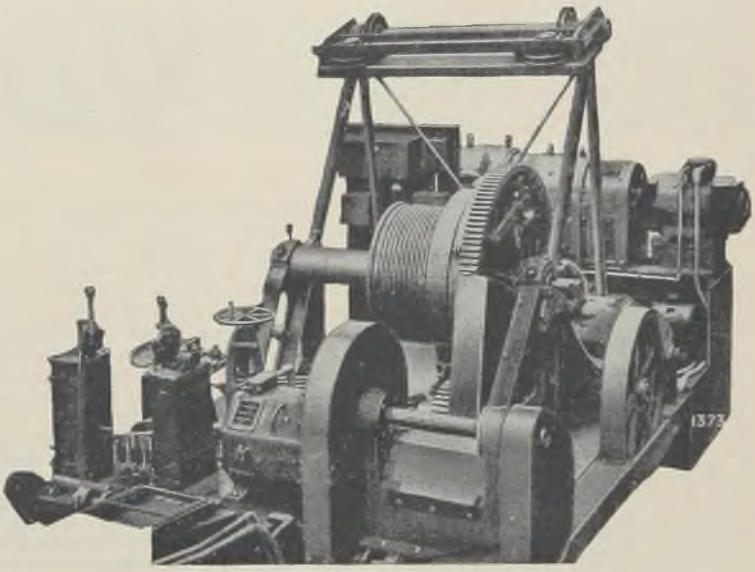


WALKER BROS. AIR-COMPRESSOR.

British Boiler Circulators, Ltd., of 8, Broadway, Westminster, London, S.W. 1, publish some particulars describing their patent circulators for improving the steam raising capacity of Lancashire and Cornish boilers. The circulator is fixed in position by means of chains and adjusting screws encircling the flues and can be fitted in a few hours, no interference with the boiler structure itself being necessary. It consists of a light form of steel construction and the top plate of the circulator may be easily removed to give access to the fusible plug without disturbing the position of the circulator. It is claimed on behalf of it that an increase of overall boiler capacity by 10% is obtained and from 5 to 10% saving in fuel consumption ; also greater elasticity in steam raising since all cold water can be raised to a uniform steam temperature and working pressure in from 40 to 50 mins.

Greenwood and Batley, Ltd., of Albion Works, Leeds, have issued a booklet describing their electric locomotives for underground and other haulage purposes. More particularly this deals with battery locomotives of which a number of different sizes are made, including those of flame-proof type suitable for colliery operations. The heaviest is an eight ton with a drawbar pull of 2,100 to 2,600 lb. Another is a three ton with a drawbar pull of 600 to 1,200 lb., several of which are operating at the present time in Western Australian gold mines, and a smaller type is a 1¾ ton tramming or gathering locomotive with a pull of 360 to 700 lb. A special feature of these locomotives that may be noted is the cast steel axle box fitted with roller bearings and carried in machined guides with renewable facings, the frame being supported on double helical springs and provision made for grease-gun lubrication. The controller is of the cam contactor type. Another feature is that the driving motor and axle are of unit construction. Particulars are given in the booklet of the arrangements for recharging batteries and in addition there are some details of collector type mining locomotives, one such being a five ton machine with a drawbar pull of 2,000 lb.

Ruston-Bucyrus, Ltd., of Lincoln, have just issued a new catalogue describing their 52-B 2¼-yard Ward-Leonard electric shovel. The essential feature distinguishing this shovel from the others in this range of Ruston-Bucyrus products is, of course, the electrical equipment. The digging, slewing, and thrusting motions are driven by separate d.c. motors. The fields of these motors are separately excited and the armature circuits are directly connected to the armatures of three variable-voltage generators. There are no controls in the armature circuits, which are made up of continuous copper circuits with permanent connexions. Thus absolute control of both speed and torque of the three motors is obtained by varying the field current of the generators connected to them and for this reason light, easily operated, drum type controllers can be used. These are in reality only field rheostats that handle very small currents so that the contact fingers are not subjected to burning and rapid wear. The three generators are driven by a squirrel-cage a.c. motor designed to suit the electrical power available. The arrangement of the equipment is well shown in the illustration. The following are brief particulars of the electrical equipment :—The four-unit Ward-Leonard set consists of—One 100 h.p., 1,450 r.p.m., three phase, squirrel-cage induction motor, one 55 k.w., 250 volt, 1,450 r.p.m., d.c. hoist generator, and two 20 k.w., 250 volt, 1,450 r.p.m., d.c. swing and thrust generators. The exciter set is a 4·5 k.w., 125 volt, 1,450 r.p.m., compound-wound generator and a 6·5 h.p., three phase, 50 cycle squirrel cage induction motor. The hoist motor is a 60 h.p., 230 volt, mill type, motor and the swing motor is a 23 h.p., 230 volt, 650 r.p.m. like the hoist motor, the thrust motor being similar to the swing. They also announce that they have recently received an order for 13 excavators for Russia, five of which are



Ruston-Bucyrus Ward-Leonard Electric Shovel Equipment.

No. 4 ½-yard Diesel shovels, including sets of grabbing equipment, and the remaining eight are caterpillar mounted Diesel grabbing cranes, all of which are fitted with Ruston and Hornsby engines.

Vickers-Armstrongs, Ltd., of Elswick Works, Newcastle-on-Tyne, have issued some supplementary information with regard to duralumin skips. In the last issue of the MAGAZINE, as also elsewhere in this issue, reference has been made to the employment of these skips and cages which have been satisfactorily tried out on a number of mines in South Africa, notably at Randfontein. As has been indicated elsewhere the skips or cages are made of a composite construction consisting of duralumin body built up out of plates or rolled sections, riveted together, with fittings of steel and forged duralumin. This is carried in a mild steel bridle frame and the inside of the body is lined with removable liners of manganese steel. The bottoms of the skips have in many cases been lined with Linatex rubber lining, the product of the **Wilkinson Process Rubber Co., Ltd.**, the purpose of which is to resist the abrasion and shattering due to the impact of the ore being dumped from loading shutes, in addition to which the Linatex has the effect of preventing the aggregation of the finer particles of the ore at the bottom of the cage and their refusal to fall out when tipping. In addition to skips for vertical shafts, similarly lightened skips have been constructed for use in inclined shafts. These skips are guided by rollers running on guides fixed to the shaft side, the rollers being of steel mounted on steel shafts carried in bearings of which the housings are made from duralumin forgings. Particulars are given of the nature of the treatment to which duralumin is subjected including its heat treatment in course of manufacture. In case of damage to the body of the skips comparatively small deflections can be repaired cold. More serious damage is repaired by warming the metal with blow lamps or in extreme cases dismantling, repairing, and heat treating subsequently.

METAL MARKETS

COPPER.—The copper market remained fairly colourless during June until the close of the month, when it was announced that certain big producers were breaking away from the international agreement and this threw the market into the melting-pot. The quotations of Copper Exporters had only nominal significance during the month and by the end of June outsiders were selling at down to 5·15 cents c.i.f. Europe. The American import duty of 4 cents per lb. came into effect during June. Standard prices underwent only moderate fluctuations. Much interest was aroused by the announcement that a big British refinery is to be erected forthwith at Prescot, Lancs., to work on Rhodesian blister copper.

Average price of Cash Standard Copper: June, 1932, £26 18s. 4d.; May, 1932, £28 11s. 11d.; June, 1931, £35 17s. 6d.; May, 1931, £38 18s. 10d.

TIN.—Values were irregular at the beginning of last month and sentiment received a shock when a big metal broking firm failed with a large position open in tin. Although the situation was cleared up satisfactorily, a certain amount of nervousness remained. Subsequently, however, the announcement that the amended Byrne scheme for further intensifying the curtailment of production was definitely going into effect on July 1 tended to create mild optimism, as did also the lively expectation that supplies in sight would show a marked diminution over June when the monthly statistics were published. Industrial demand, however, remained rather subdued.

Average price of Cash Standard Tin: June, 1932, £114 12s. 11d.; May, 1932, £122 7s. 6d.; June, 1931, £108 0s. 8d.; May, 1931, £104 8s.

LEAD.—The general drift of values during June was downwards, which was only to be expected in view of the continued dullness of demand and the fact that the unwieldy surplus stocks already in existence are still being added to. Conferences of producers held to arrange further international co-operation in this industry have so far had no result. In the United States stocks have grown still larger, but over the summer months even more drastic output-curtailment will be witnessed there, so that this tendency may be checked in the near future.

Average mean price of soft foreign lead: June, 1932, £9 15s.; May, 1932, £10 17s. 1d.; June, 1931, £11 15s. 4d.; May, 1931, £11 12s. 8d.

SPELTER.—On balance, prices have been fairly steady and sentiment has remained comparatively cheerful, partly on account of the steady diminution in the stocks reported as held by the International Cartel. Industrial demand generally has, however, been unsatisfactory. In Germany endeavours have been made by producers to secure an import duty as a means of protecting the industry there, but this effort has proved unsuccessful; the authorities are, however, apparently prepared to grant the mines and smelters a substantial annual grant, nominally repayable later on.

Average mean price of spelter: June, 1932, £11 14s. 1d.; May, 1932, £12 11s. 1d.; June, 1931, £11 10s. 2d.; May, 1931, £10 13s. 7d.

IRON AND STEEL.—The chief event last month was the raising of the British import duty on pig-iron from 10 to 33⅓%, but this has so far had no material effect on business. Indian pig-iron, the chief competitor of British pig, is still allowed to enter this country free. Sentiment, however, is more hopeful, partly on expectations that Empire trade may be fostered by the discussions at Ottawa. An encouraging sign is the decision to blow in two fresh hematite furnaces in the Middlesbrough district. As regards prices, Cleveland quotations are steady, with the official minimum for No. 3 foundry still 58s. 6d., although less is accepted for Scottish. In finished steel, the mills have benefited from some Russian contracts and a big engineering concern has hopes of booking an order for a large Danish bridge. The shipbuilding industry, however, is stagnant and the mills generally are in want of business.

IRON ORE.—The continued depression in the iron and steel industry precludes any new business of appreciable size in iron ore, especially as most works are still covered for months ahead under old contracts. Best Bilbao rubio, however, remains at about 15s. per ton c.i.f.

ANTIMONY.—The market has remained stagnant throughout the past month and prices have eased to about £17 c.i.f. for Chinese regulus for forward shipment and about £22 10s. to £23 ex warehouse for spot.

ARSENIC.—Demand is not impressive, but prices are steadily maintained at £22 5s. to £22 10s. c.i.f.

LONDON DAILY METAL PRICES.

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

	COPPER.									TIN.						ZINC (Spelter).			LEAD.				SILVER.		GOLD.		
	STANDARD.						ELECTRO-LYTIC.			BEST SELECTED.									SOFT FOREIGN.			ENGLISH.			Cash.	Forward.			
	Cash.			3 Months.																									
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s.	d.	
June																													
10	26	6	10½	26	4	4½	31	0	0	29	5	0	112	2	6	114	12	6	11	10	0	9	11	3	11	10	0	16 7/16	16 7/16	112	9
13	27	4	4½	27	0	7½	31	5	0		—		115	2	6	117	12	6	11	11	3	9	10	0	11	10	0	16 7/16	16 15/16	112	8
14	27	3	9	27	0	7½	31	5	0	29	15	0	113	7	6	115	12	6	11	8	9	9	5	0	11	5	0	16 7/16	16 15/16	112	8
15	27	4	4½	26	19	4½	31	5	0		—		111	6	3	113	17	6	11	7	6	9	3	9	11	5	0	16 15/16	16 7/16	112	11
16	27	6	10½	27	1	3	31	5	0		—		112	2	6	114	11	3	11	11	3	9	5	0	11	5	0	16 15/16	16 7/16	112	10
17	27	16	10½	27	10	7½	32	0	0	30	10	0	114	2	6	116	10	0	11	16	3	9	15	0	11	10	0	16 15/16	17	113	1
20	28	3	9	27	16	3	32	0	0		—		114	12	6	117	2	6	11	12	6	9	13	9	11	10	0	16 15/16	17	114	0
21	27	11	10½	27	6	10½	32	0	0	30	10	0	113	17	6	116	2	6	11	11	3	9	12	6	11	10	0	17	17 1/16	114	5
22	27	12	6	27	6	10½	32	0	0		—		116	7	6	118	12	6	11	10	0	9	13	9	11	10	0	16 15/16	16 15/16	114	0
23	27	1	10½	26	16	10½	31	10	0		—		114	17	6	117	2	6	11	8	9	9	11	3	11	10	0	16 7/16	16 7/16	114	2
24	27	5	7½	27	0	7½	31	10	0	29	5	0	114	2	6	116	7	6	11	3	9	9	13	9	11	10	0	16 7/16	16 15/16	114	6
27	27	1	3	26	15	7½	31	10	0		—		110	7	6	112	12	6	11	3	9	9	8	9	11	5	0	16 15/16	16 7/16	114	4
28	26	16	3	26	11	3	31	10	0	29	0	0	110	17	6	113	2	6	11	5	0	9	7	6	11	5	0	16 7/16	16 15/16	114	7
29	26	1	10½	25	16	10½	31	0	0		—		114	17	6	116	12	6	11	3	9	9	7	6	11	5	0	16 15/16	16 7/16	114	8
30	25	10	0	25	4	4½	30	10	0		—		117	7	6	118	17	6	11	6	3	9	8	9	11	5	0	16 7/16	16 15/16	114	8
July																													
1	25	13	1½	25	6	3	30	0	0	28	0	0	123	17	6	125	7	6	11	8	9	9	13	9	11	15	0	16 15/16	16 7/8	115	0
4	26	8	9	25	13	9	31	0	0		—		121	12	6	123	7	6	11	8	9	10	0	0	12	0	0	16 7/16	16 15/16	116	0
5	27	3	1½	26	9	4½	31	0	0	29	5	0	123	15	0	125	8	9	11	15	0	10	5	0	12	5	0	16 7/8	16 15/16	116	5
6	27	6	3	26	16	3	31	0	0		—		124	2	6	125	7	6	11	13	9	10	0	0	12	0	0	16 13/16	16 7/8	116	0
7	27	3	9	26	16	3	31	5	0		—		127	12	6	128	17	6	11	11	3	10	1	3	12	0	0	16 7/16	16 7/8	115	8
8	27	0	0	26	11	10½	30	10	0	29	5	0	126	12	6	128	6	3	11	16	3	10	1	3	12	0	0	16 7/16	16 15/16	115	7
11	26	18	1½	26	8	1½	30	15	0		—		124	17	6	126	7	6	11	11	3	10	5	0	12	5	0	17 1/16	17 1/8	115	7

for high-grade Mexican and £24 10s. f.o.r. mines for 99% Cornish white.

BISMUTH.—Quite a good demand is reported at the unaltered official price of 4s. 6d. per lb. for merchant quantities.

CADMIUM.—A steady but restricted inquiry is maintained, prices being about 1s. 11d. to 2s. per lb., according to quantity.

COBALT.—Metal is still priced officially at 7s. 6d. per lb., but demand is slow and this figure is shaded for good contracts.

COBALT OXIDES.—Competition for the limited business that is passing is keen and prices are rather variable. However, about 4s. 3d. per lb. is named for black and 5s. to 5s. 2d. for grey.

CHROMIUM.—About 2s. 9d. per lb. delivered is still quoted, the plating trade remaining a fair buyer.

TANTALUM.—Current quotations are in the neighbourhood of £15 to £20 per lb.

PLATINUM.—Demand recently has been distinctly small, but supplies are strongly controlled and prices remain unaltered at £9 9s. to £9 15s. per oz. for refined metal.

PALLADIUM.—The market is dull, but quotations are unaltered at £4 to £4 5s. per oz.

IRIDIUM.—Only very limited quantities are changing hands, but sponge and powder remain at £12 to £14 per oz.

OSMIUM.—There is no change to report, business being slow at the unchanged prices of £11 10s. to £13 10s. per oz.

TELLURIUM.—Sales are restricted to trifling quantities, for which somewhere about 20s. per lb. are obtained.

SELENIUM.—High grade black powder is steadily maintained at 7s. 8d. to 7s. 9d. per lb. (gold) ex warehouse.

MANGANESE ORE.—Deadly dull conditions rule in this market, business being to all intents and purposes at a standstill. Prices are nominal at around 9d. to 9½d. per unit c.i.f. for best Indian ore and 8½d. to 9d. c.i.f. for good 48% Indian and washed Caucasian, minimum 50% Mn.

ALUMINIUM.—There is nothing much moving at the present time, but prices are firmly upheld at the old levels of £95 for ingots and bars and £97 for rolling billets, both less 2% delivered.

SULPHATE OF COPPER.—Quite a good demand has been in evidence for this article recently, but in sympathy with copper quotations prices have eased to £16 5s. to £16 15s. per ton, less 5% for English.

NICKEL.—Demand is very mediocre, but with sterling easier prices here have been raised to £230 to £235 per ton, according to quantity.

CHROME ORE.—Business continues meagre, the heavy falling-off in the Rhodesian output being a good indication of the decline in consumption. Prices, however, are unchanged at about 80s. to 85s. per ton c.i.f. for good 48% Rhodesian ore, and 100s. to 110s. c.i.f. for 55 to 57% New Caledonian.

QUICKSILVER.—With the removal of the 10% import duty and a continued lack of demand prices have eased to about £11 15s. per bottle net for spot material.

TUNGSTEN ORE.—Demand remains to all intents and purposes at a standstill and sellers are now offering forward shipment from China at down to 11s. 3d. per unit c.i.f.

MOLYBDENUM ORE.—A very fair inquiry persists, but supplies are scarce and prices are inclined to be nominal at 37s. 6d. to 39s. per unit c.i.f.

GRAPHITE.—The market is dull, but quotably unchanged at £16 to £18 c.i.f. for good 85 to 90% Madagascar raw flake and £17 to £17 c.i.f. for 90% Ceylon lumps.

SILVER.—June opened with the market quietly steady. The Continent was rather inclined to sell, but this was largely offset by small purchases by India and China. Spot bars were 16 1/16d. on June 1, moving within very narrow limits during the first half of the month to 16 3/16d. on June 15. A better tone was seen temporarily when American demand accompanied the strengthening of the dollar, but with the Continent still inclined to sell, spot bars after touching 17d. eased again, closing at 16 5/8d. on June 30.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
June, 1931	867,949	42,330	910,279
July	855,073	42,677	897,750
August	872,198	44,645	916,843
September	870,822	45,603	916,425
October	872,053	43,971	916,024
November	900,353	44,760	945,113
December	855,102	45,408	900,510
January, 1932	877,178	46,175	923,353
February	890,688	46,096	936,784
March	869,711	44,301	914,012
April	914,017	46,018	960,035
May	901,894	47,902	949,796
June	913,297	45,714	959,011

TRANSVAAL GOLD OUTPUTS.

	May.		June.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	103,000	£155,125	107,000	£160,658
City Deep	84,000	21,637	84,500	21,789
Cons. Main Reef	70,300	23,099	71,000	23,657
Crown Mines	280,000	86,522	278,000	86,067
Daggafontein	41,000	£65,007	41,700	£66,197
D'rb'n Roodepoort Deep	50,000	15,613	48,000	16,009
East Geduld	58,700	18,502	59,000	18,929
East Rand P.M.	161,000	42,456	157,000	40,595
Geduld	86,500	27,477	83,000	26,621
Geldenhuis Deep	71,000	16,594	74,000	16,829
Glynn's Lydenburg	5,700	2,540	6,400	2,554
Government G.M. Areas	208,000	£408,056	208,000	£406,976
Kleinfontein	53,300	10,039	51,600	10,298
Langlaagte Estate	80,000	£112,381	81,000	£109,856
Luipaard's Vlei	34,500	8,644	33,400	8,395
Meyer and Charlton	17,200	£18,166	16,000	£15,576
Modderfontein New	171,000	65,651	167,000	64,621
Modderfontein B	77,500	21,853	75,000	21,166
Modderfontein Deep	44,600	21,619	44,400	21,570
Modderfontein East	73,500	21,388	73,500	21,242
New State Areas	88,000	£181,853	89,000	£184,036
Nourse	71,500	21,137	69,500	20,751
Randfontein	250,000	£291,999	240,000	£282,984
Robinson Deep	100,000	28,447	98,000	28,724
Rose Deep	65,000	13,043	60,500	12,610
Simmer and Jack	81,900	21,843	78,000	21,977
Springs	75,800	£163,191	76,100	£164,566
Sub Nigel	37,000	32,426	36,000	32,453
Transvaal G.M. Estates	19,100	5,422	18,500	5,255
Van Ryn	51,000	£46,029	50,000	£41,873
Van Ryn Deep	69,000	£90,577	70,000	£92,702
West Rand Consolidated	96,500	£106,681	93,500	£103,438
West Springs	75,000	£80,557	77,500	£80,839
Witw'tersr'nd (Knights)	68,000	£55,278	65,000	£55,461
Witwatersrand Deep	45,500	14,384	46,100	14,968

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.	£
March, 1931	2,718,400	28 2	19 9	8 5	1,151,017
April	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	2,793,900	27 10	19 5	8 5	1,173,732
January, 1932	2,880,500	27 5	19 4	8 1	1,163,434
February	2,775,400	27 8	19 6	8 2	1,133,212
March	2,901,300	27 10	19 7	8 3	1,200,278
April	2,883,500	27 9	19 5	8 4	1,196,011
May	—	—	—	—	1,228,198

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
June 30, 1931	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
March 31	214,024	12,009	—	226,033
April 30	214,334	11,943	—	226,277
May 31	215,926	11,972	—	227,898
June 30	217,077	11,833	—	228,910

PRODUCTION OF GOLD IN RHODESIA.

	1929	1930	1931	1932
	oz.	oz.	oz.	oz.
January	46,231	46,121	45,677	42,706
February	44,551	43,385	42,818	45,032
March	47,388	45,511	42,278	47,239
April	48,210	45,806	43,776	46,487
May	48,189	47,645	43,731	46,854
June	48,406	45,208	44,118	—
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.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	9,783	24,800	11,667
Globe and Phœnix	6,278	6,408	6,110	6,368
Lonely Reef	8,500	2,503	8,500	2,474
Luiri Gold	1,496	334	—	£15,457
Rezende	6,500	2,588	6,500	2,593
Sherwood Star	4,800	£8,228	4,800	£8,321
Wanderer Consolidated	16,700	3,383	15,300	3,157

WEST AFRICAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,304	£14,676	5,088	£15,457
Ashanti Goldfields	13,353	14,611	13,300	14,608
Taquah and Abosso	10,112	3,410	10,391	3,391

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
June, 1931	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	—	916
February	44,672	—	981
March	47,103	—	769
April	48,936	—	—
May	53,928	—	—
June	50,079	—	—

† Sept. and Oct.

AUSTRALASIAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,432	6,621	5,281	8,753
Blackwater (N.Z.)	3,574	8,001	3,540	8,395
Boulder Persev'ce (W.A.)	6,801	14,412	7,211	14,706
Grt. Boulder Pro. (W.A.)	7,699	20,348	7,762	23,183
Lake View & Star (W.A.)	26,488	33,558	—	—
Sons of Gwalia (W.A.)	12,138	14,659	12,154	14,522
South Kalgurli (W.A.)	9,183	15,844	9,241	16,409
Waihi (N.Z.)	18,643	{ 5,251 53,664	18,302	{ 6,177* 41,114†
Wiluna	27,096	35,182	—	—

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	May.		June.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	1,650	2,225	—	1,809
Champion Reef	9,300	5,421	8,970	5,524
Mysore	14,636	7,351	14,310	7,088
Nundydroog	12,583	7,368	12,514	7,408
Ooregum	11,170	4,380	11,980	4,387

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	May.		June.	
	Tons	Value £	Tons	Value £
Bulolo Gold	—	66,000*d*†	—	—
Chosen Corp. (Korea)	10,640	19,337	9,660	13,250
Frontino Gold (C'lbia)	3,740	14,680	3,860	18,011
Fresnillo	77,114	3,000*d*‡	—	—
New Goldfields of Venezuela	6,819	1,638*	7,651	2,306*
Oriental Cons. (Korea)	17,094	92,117	—	80,858*d*
St. John del Rey (Brazil)	—	41,500	—	40,600
Santa Gertrudis (Mexico)	24,251	59,532*d*	—	—
Viborita	—	1,820	—	—
West Mexican Mines	1,550	17,200*d*	—	—

d Dollars. * Oz. gold. † To May 22. ‡ Loss

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	2,132
September	2,449	March	3,064
October	3,282	April	3,333
November	2,488	May	2,276
December	3,222	June	2,491

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	April.	May.	June.
Ayer Hitam	24	—	38½
Batu Caves	16	—	—
Changkat	48	68	—
Gopeng	38	—	27
Hongkong Tin	48	—	35½
Idris Hydraulic	18½	—	13½
Ipoh	119¾	27	34⅝
Kampar Malaya	—	—	—
Kampong Lanjut	35	30	42
Kamunting	150	99⅛	117
Kent (F.M.S.)	—	—	—
Killinghall	21¾	22½	46
Kinta	11	—	12½
Kinta Kellas	23	—	—
Kramat Tin	120	72	60
Kuala Kampar	43	33	42
Kundang	—½	—	—
Lahat	27½	15⅞	14⅛
Lower Perak	—	—	—
Malaya Consolidated	—	—	—
Malayan Tin	95½	54½	71½
Malim Nawar	25	25	22
Pahang	125	125	105
Penawat	70	47½	42½
Pengkalen	15	—	25
Petaling	169½	—	100
Rahman	40⅝	40⅝	—
Rambutan	—	—	4½
Rantau	12½	—	—
Rawang	38	44	38
Rawang Concessions	40	48	21
Renong	15	19½	20⅜
Selayang	16¼	—	9½
Southern Kampar	88	—	60
Southern Malayan	107½	27½	70
Southern Perak	50½	—	25½
Southern Tronoh	42	2⅜	19½
Sungei Besi	32½	33	27
Sungei Kinta	34⅜	33⅜	32½
Sungei Way	68½	9	41½
Taiping	14½	11	—
Tanjong	—	—	12⅛
Tekka	27	—	18
Tekka-Taiping	42½	—	24½
Temoh	—	—	—
Tronoh	52	66	43½
Ulu Klang	—	—	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	April.	May.	June.
Anglo-Nigerian	15½	7¼	15½
Associated Tin Mines	120	114	145½
Baba River	1⅛	—	—
Batura Monguna	3	—	1
Bisichi	25	16	25
Daffo	4	—	—
Ex-Lands	41	15	—
Filani	1½	2	—
Jantar	11	13	10
Jos	12¾	13½	—
Juga Valley	8	8	8
Kaduna Syndicate	17	17	—
Kaduna Prospectors	8	8	—
Kassa	5½	4½	7
London Tin	145	48	102
Lower Bisichi	¾	1	—
Naraguta Extended	—	—	—
Nigerian Consolidated	7	7	7
Otto River	5	—	—
Ribon Valley	13	4	18
Tin Fields	—	—	—
United Tin Areas	18	—	17
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	April.	May.	June.
Anglo-Burma (Burma)	17⅛	12⅜	—
Aramayo Mines (Bolivia)	132	106	84
Bangrin (Siam)	42	57	61¼
Beralt	28½*	29*	—
Consolidated Tin Mines (Burma)	95	82	83
East Pool (Cornwall)	49⅜	50½	—
Fabulosa (Bolivia)	45†	43†	41†
Kagera (Uganda)	26	22	—
Kamra	—	—	—
Malaysiam Tin	8⅜	8½	13
Mawchi	236*	230*	208*
Patino	813	813	—
Pattani	—	—	—
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	147	92½	79
South Crofty	59	50⅜	52¾
Tavoy Tin (Burma)	50	73½	91
Tongkah Harbour (Siam)	43	35	30
Toyo (Japan)	81⅜	80	70
Zaaiplaats	15½	—	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		May.	June.
Britannia Lead	Tons refined lead.	3,855	—
	Oz. refined silver.	214,027	—
Broken Hill South	Tons lead conc.	4,425	4,698
	Tons zinc conc.	4,296	5,045
Burma Corporation	Tons refined lead.	5,880	5,880
	Oz. refined silver	520,876	530,615
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	370	370
Messina	Tons copper	823	810
Mount Isa	Tons lead bullion	3,500	—
Mount Lyell	Tons concentrates	3,639†	4,294*
North Broken Hill	Tons lead conc.	5,030	5,890
	Tons zinc conc.	4,750	5,560
Rhodesia Broken Hill	Tons V_2O_5	32	30
	Tons V_2O_5 conc.	100	100
Roan Antelope	Tons concentrates	—	—
	Tons blister copper	1,972	2,089
Sulphide Corporation	Tons lead conc.	1,651	—
	Tons zinc conc.	2,536	—
Trepca	Tons lead conc.	4,284	4,671
	Tons zinc conc.	6,276	6,093
Villemagne	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Zinc Corporation	Tons lead conc.	5,539	4,391
	Tons zinc conc.	3,637	3,237

* To June 15. † To May 18.

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

		April.	May.
Iron Ore	Tons	137,898	162,103
Manganese Ore	Tons	11,046	4,595
Iron and Steel	Tons	144,535	144,013
Copper and Iron Pyrites	Tons	52,265	35,484
Copper Ore, Matte, and Prec.	Tons	1,576	4,894
Copper Metal	Tons	8,710	10,534
Tin Concentrate	Tons	5,307	4,293
Tin Metal	Tons	276	250
Lead Pig and Sheet	Tons	17,030	22,457
Zinc (Spelter)	Tons	5,880	6,605
Zinc Sheets, etc.	Tons	472	1,263
Zinc Oxide	Tons	73	2
Zinc Ore	Tons	6,742	7,074
Aluminium	Tons	184	504
Mercury	Lb.	57,852	79,312
White Lead	Cwt.	3,714	1,738
Barytes, ground	Cwt.	14,427	16,007
Asbestos	Tons	2,143	1,646
Boron Minerals	Tons	454	602
Borax	Cwt.	24,771	12,184
Basic Slag	Tons	1,930	850
Superphosphates	Tons	7,930	2,852
Phosphate of Lime	Tons	24,232	29,668
Mica	Tons	148	78
Tungsten Ores	Tons	405	237
Sulphur	Tons	8,131	3,606
Nitrate of Soda	Cwt.	—	10,074
Potash Salts	Cwt.	124,534	44,248
Petroleum : Crude	Gallons	24,626,505	34,086,562
Lamp Oil	Gallons	23,218,161	10,250,317
Motor Spirit	Gallons	78,166,958	89,077,618
Lubricating Oil	Gallons	12,735,465	9,454,659
Gas Oil	Gallons	9,492,979	6,593,430
Fuel Oil	Gallons	44,255,168	43,925,353
Asphalt and Bitumen	Tons	12,095	10,021
Paraffin Wax	Cwt.	87,946	84,033

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	April.	May.	June.
Anglo-Ecuadorian	16,766	17,113	—
Apex Trinidad	45,170	44,670	47,140
Attock	1,489	2,626	2,056
British Burmah	3,935	3,691	3,767
British Controlled	46,362	44,289	40,318
Kern Mex	1,008	1,091	980
Kern River (Cal.)	2,296	2,358	1,999
Kern Romana	194	178	164
Kern Trinidad	2,530	1,845	1,863
Lobitos	24,004	24,809	—
Phœnix	68,787	68,380	—
St. Helen's Petroleum	4,793	5,208	4,675
Steaua Romana	89,930	91,182	84,604
Tampico	2,738	2,891	2,596
Tocuyo	981	1,283	1,056
Trinidad Leaseholds	25,600	31,050	28,950

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	June 9, 1932.			July 11, 1932.		
	£	s.	d	£	s.	d.
Anglo-Ecuadorian		5	6		6	0
Anglo-Egyptian B.	1	0	0	1	3	0
Anglo-Persian 1st Pref.	1	2	6	1	7	9
" " Ord.	1	4	6	1	14	3
Apex Trinidad (5s.)		9	9		10	9
Attock		10	0		9	6
British Burmah (8s.)		3	6		3	3
British Controlled ($5)			10		1	3
Burmah Oil	1	18	0	2	6	3
Kern River Cal. (10s.)		1	6		1	6
Lobitos, Peru	1	1	3	1	5	6
Mexican Eagle, Ord. (4 pesos)		5	0		6	0
" " 8% Pref. (4 pesos)		5	0		5	9
Phœnix, Roumanian		3	0		4	6
Royal Dutch (100 fl.)	12	12	6	14	12	6
Shell Transport, Ord	1	10	6	1	16	9
" " 5% Pref. (£10)	10	0	0	11	0	0
Steaua Romana		4	0		5	6
Trinidad Leaseholds	1	2	6	1	7	6
United British of Trinidad (6s. 8d.)		1	9		2	0
V.O.C. Holding		18	0	1	3	0

PRICES OF CHEMICALS. July 11.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
" 80%	"	1	16	5
" Glacial	per ton	59	0	0
Alum	"	8	7	6
Aluminium Sulphate, 17 to 18%	"	6	15	0
Ammonium, Anhydrous	per lb.		1	0
" 0·880 solution	per ton	15	10	0
" Carbonate	"	27	10	0
" Nitrate (British)	"	16	0	0
" Phosphate, comml.	"	40	0	0
" Sulphate, 20·6% N.	"	5	5	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
" Sulphide, golden	"			9
Arsenic, White (foreign)	per ton	24	0	0
Barium, Carbonate (native), 94%	"	4	10	0
" Chloride	"	10	10	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	7
" " crystallized, 40°	per lb.			6½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.		1	0½
Copper Sulphate	per ton	15	10	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5
Cresylic Acid, 98 100%	"		1	4
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	0	4
Iron, Nitrate 80° Tw.	per ton	6	0	0
" Sulphate	"	1	17	6
Lead, Acetate, white	"	35	0	0
" Nitrate (ton lots)	"	27	10	0
" Oxide, Litharge	"	27	10	0
" White	"	37	10	0
Lime, Acetate, brown	"	8	5	0
" " grey, 80%	"	11	10	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	7	0
Phosphoric Acid. (Conc. 1·750)	per lb.			10
Pine Oil	per cwt.	2	7	6
Potassium Bichromate	per lb.			5
" Carbonate, 96/98%	per ton	28	10	0
" Chlorate	per lb.			4
" Chloride 80%	per ton	12	10	0
" Ethyl Xanthate	per 100 kilos	7	0	0
" Hydrate (Caustic) 88/90%	per ton	40	0	0
" Nitrate	"	30	0	0
" Permanganate	per lb.			8½
" Prussiate, Yellow	"			8½
" " Red	"		2	0
" Sulphate, 90%	per ton	14	10	0
Sodium Acetate	"	20	0	0
" Arsenate, 45%	"	28	0	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.			4
" Carbonate (Soda Ash) 58%	per ton	6	0	0
" " (Crystals)	"	5	5	0
" Chlorate	"	28	10	0
" Cyanide 100% NaCN basis	per lb			8
" Ethyl Xanthate	per 100 kilos	6	12	6
" Hydrate, 76%	per ton	14	0	0
" Hyposulphite, comml.	"	9	2	6
" Nitrate (ordinary)	"	9	0	0
" Phosphate, comml.	"	12	10	0
" Prussiate	per lb.			5
" Silicate	per ton	9	10	0
" " (liquid, 140° Tw.)	"	8	10	0
" Sulphate (Glauber's Salt)	"	2	15	0
" " (Salt-Cake)	"	3	1	0
" Sulphide Conc., 60/65%	"	10	15	0
" Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
" Roll	"	10	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	0	0
Tartaric Acid	per lb.		1	0½
Turpentine	per ton	61	10	0
Tin Crystals	per lb.		1	0
Titanous Chloride	"			10½
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:	June 9, 1932. £ s. d.	July 11, 1932. £ s. d.
SOUTH AFRICA:		
Brakpan	3 12 0	3 12 6
City Deep	4 6	5 0
Consolidated Main Reef	1 1 0	1 3 6
Crown Mines (10s.)	5 1 3	5 7 6
Daggafontein	2 7 6	2 13 0
Durban Roodepoort Deep (10s.)	18 0	18 9
East Geduld	2 19 0	3 2 0
East Rand Proprietary (10s.)	11 3	12 3
Geduld	4 3 9	4 7 0
Geldhenhuis Deep	11 0	10 9
Glynn's Lydenburg	6 3	6 3
Government Gold Mining Areas (5s.)	1 13 9	1 13 0
Grootvlei	1 0 0	1 1 3
Langlaagte Estate	17 6	18 0
Meyer & Charlton	1 10 0	1 10 0
Modderfontein New (10s.)	2 10 0	2 6 3
Modderfontein B (5s.)	11 3	10 6
Modderfontein Deep (5s.)	17 6	14 6
Modderfontein East	1 16 3	2 1 3
New State Areas	2 11 3	2 11 3
Nourse	15 0	16 9
Randfontein	1 6 9	1 11 3
Robinson Deep A (1s.)	15 6	15 0
" " B (7s. 6d.)	9 9	10 3
Rose Deep	5 3	6 3
Simmer & Jack (2s. 6d.)	3 4	3 9
Springs	3 15 0	3 15 6
Sub Nigel (10s.)	4 3 9	4 13 9
Van Ryn	11 3	11 3
Van Ryn Deep	1 0 6	18 0
Village Deep (9s. 6d.)	2 6	1 6
West Rand Consolidated (10s.)	11 9	13 0
West Springs	13 3	14 0
Witwatersrand (Knight's)	7 0	8 0
Witwatersrand Deep	5 6	7 0
RHODESIA:		
Cam and Motor	1 16 3	2 1 3
Gaika	3 6	3 6
Globe and Phœnix (5s.)	15 6	16 3
Lonely Reef	15 0	12 6
Mayfair	4 6	4 6
Rezende	1 10 0	1 7 6
Shamva	1 0	1 0
Sherwood Starr (5s.)	14 6	15 6
GOLD COAST:		
Ashanti (4s.)	1 9 0	1 12 3
Taquah and Abosso (5s.)	5 6	5 0
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	4 0	4 0
Great Boulder Propriet'y (2s.), W.A.	6 9	7 3
Lake View and Star (4s.), W.A.	10 6	12 3
Sons of Gwalia, W.A.	8 9	10 0
South Kalgurli (10s.), W.A.	18 0	1 1 0
Waihi (5s.), N.Z.	13 6	14 3
Wiluna Gold, W.A.	16 6	18 0
INDIA:		
Balaghat (10s.)	8 9	11 3
Champion Reef (10s.)	11 6	13 6
Mysore (10s.)	9 0	10 3
Nundydroog (10s.)	1 0 9	1 5 6
Ooregum (10s.)	4 6	5 0
AMERICA:		
Camp Bird (2s.), Colorado	3	2
Exploration (10s.)	1 0	1 0
Frontino and Bolivia, Colombia	18 0	17 6
Mexican Corporation, Mexico (10s.)	2 6	3 0
Mexico Mines of El Oro, Mexico	2 0	2 0
St. John del Rey, Brazil	18 0	19 6
Santa Gertrudis, Mexico	5 0	6 9
Selukwe (2s. 6d.), British Columbia	1 3	1 4
MISCELLANEOUS:		
Chosen, Korea	3 0	3 0
Lena Goldfields, Russia	6	3

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	1 6	2 0
Esperanza Copper	13 9	13 9
Indian (2s.)	0 9	10
Loangwa (5s.), Rhodesia	1 3	1 3
Luiri (5s.), Rhodesia	2 0	1 6
Messina (5s.), Transvaal	3 0	4 2
Mount Lyell, Tasmania	13 9	16 0
Namaqua (£2), Cape Province	3 0	3 0
Rhodesia-Katanga	10 0	10 0
Rio Tinto (£5), Spain	11 0 0	13 10 0
Roan Antelope (5s.), Rhodesia	4 6	6 6
Tanganyika Con.	12 6	17 0
Tharsis (£2), Spain	2 1 3	2 11 3

LEAD-ZINC:	June 9, 1932. £ s. d.	July 11, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	12 9	13 0
Broken Hill, North, N.S.W.	2 5 0	2 8 9
Broken Hill South, N.S.W.	1 12 6	1 13 9
Burma Corporation (10 rupees)	7 0	8 0
Electrolytic Zinc Pref., Tasmania	16 3	16 3
Mount Isa, Queensland	7 6	8 6
Rhodesia Broken Hill (5s.)	9	9
San Francisco (10s.), Mexico	5 0	6 3
Sulphide Corporation (15s.), N.S.W	6 0	6 6
ditto, Pref.	7 6	8 9
Zinc Corporation (10s.), N.S.W.	18 9	19 6
ditto, Pref.	2 15 0	2 17 6

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

DIAMONDS:		
Consol. African Selection Trust (5s.)	5 0	5 6
Consolidated of S.W.A. (10s.)	1 9	3 0
De Beers Deferred (£2 10s.)	2 0 0	3 0 0
Jagersfontein	11 3	15 0
Premier Preferred (5s.)	15 0	17 6

FINANCE, ETC.:		
Anglo-American Corporation (10s.)	4 6	7 0
Anglo-French Exploration	7 6	7 6
Anglo-Continental (10s.)	2 0	2 6
Anglo-Oriental (Ord., 5s.)	6 0	6 6
ditto, Pref.	6 0	8 0
British South Africa (15s.)	14 9	16 9
Central Mining (£8)	7 15 0	9 5 0
Consolidated Gold Fields	18 9	1 2 0
Consolidated Mines Selection (10s.)	3 6	5 0
Fanti Consols (8s.)	5 0	5 6
General Mining and Finance	13 9	17 0
Gold Fields Rhodesian (10s.)	2 9	3 0
Johannesburg Consolidated	19 0	1 3 6
London Tin Corporation (10s.)	7 0	9 3
Minerals Separation	2 2 6	2 5 0
National Mining (8s.)	3	3
Raud Mines (5s.)	3 3 9	3 8 9
Raud Selection (5s.)	5 6	7 9
Rhodesian Anglo-American (10s.)	4 0	6 0
Rhokana Corp.	2 2 6	2 17 6
Rhodesian Selection Trust (5s.)	3 0	4 0
South Rhodesia Base Metals	2 0	2 0
Tigon (5s.)	1 6	2 6
Union Corporation (12s. 6d.)	2 1 3	2 7 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.

THE OBUASI GOLDFIELD, GOLD COAST COLONY

A new memoir of the Gold Coast Geological Survey—No. 2, by N. R. Junner—deals with the geology of the Obuasi goldfield. The memoir is copiously illustrated and contains a coloured geological map and section. The author, who is director of the Gold Coast Survey, presents in this memoir the results of work commenced in 1925 and full extracts from the summary given at the end of the volume are reproduced here.

The author says that the rocks of the Obuasi district may be classified as follows, the youngest rocks at the top and the oldest at the bottom of the table :—

Superficial Deposits	Alluvium, soils, laterite and terrace gravels.
Tarkwaian System	Abotenten Series of felspathic quartzites and grits.
	Chloritoid-Phyllites.
	Dampaiyau Series of quartzites and grits.
	Kawere Group : Conglomerate, grits, argillaceous sandstones and sandy phyllites.
Birrimian System	Obuasi Series : phyllites, greywackes, volcanic and pyroclastic rocks, and hornstones.

The rocks of the Tarkwaian and Birrimian Systems are believed to be of Pre-Cambrian age. Small intrusions of granite, porphyry and felsite, rich in albite, and dykes of dolerite and diabase, cut the Birrimian rocks, while sills and dykes of gabbro and norite, dolerite, epidiorite, and amphibolite traverse the rocks of the Tarkwaian System. The granites and allied rocks are probably the oldest, and the dolerites the youngest, of the igneous rocks.

The Tarkwaian System consists essentially of light grey and white arenaceous sediments with a few thin beds of buff and pink mudstone and phyllite containing porphyroblasts of chloritoid and magnetite. Black phyllites of the type prevalent in the Birrimian have not been recognized in the Tarkwaian. The Abotenten Series consists of greenish-grey felspathic quartzites and grits, which in many places form long, wall-like outcrops. They are believed to be the equivalent of the Huni sandstones of the Tarkwa district. The chloritoid-phyllites of the Obuasi area correspond to the Tarkwa phyllites of the type locality. The Dampaiyau range is composed largely of grey and white quartzites and grits containing cross-bedded lines of hæmatite. These rocks are identical with the " banket " quartzites of the Tarkwa goldfield, and the identity is confirmed by the occurrence in the Dampaiyau quartzites of thin beds of quartz-conglomerate containing a little gold. In the Obuasi district the Kawere conglomerate is impersistent and thin and instead of one thick band of coarse conglomerate as near Tarkwa, there are two or more thin beds of conglomerate interbedded with considerable thicknesses of spotted argillaceous sandstones, sandy phyllites, and coarse grits. The name " Kawere Group " is proposed for these rocks. The conglomerates are derived from the underlying Birrimian rocks of the neighbourhood, and consist of flattened pebbles and flakes of altered phyllites and lavas, and rounded pebbles of hornstone and quartz.

The Birrimian rocks consist predominantly of grey and black slates, phyllites and sericite-schists, with subordinate sandy phyllites, greywackes, and ashes. Purely arenaceous sediments are absent. Some of the dark-coloured argillaceous slates and phyllites contain appreciable amounts of carbonaceous matter. Contemporaneous intermediate and basic volcanic and pyroclastic rocks, composed chiefly of chlorite, carbonate, and albite, are particularly prominent near the top of the System. The original rocks appear to have been andesites and basalts. Some of them are vesicular. The meta-basalt of the Sansu and Moinsi ranges is a metamorphosed fine-grained basic igneous rock composed of actinolite laths, epidote, zoisite, and some chlorite and albite. Coarser grained intrusive rocks having a similar mineral composition are associated in places with the meta-basalt. Metasomatically altered dykes of this type occur in the footwall of the Cote d'Or reef at the surface, and in the lower levels of the Ashanti mine. Wide " reefs " of hornstone, which have been formed by the replacement of phyllites by silica, are conspicuous in the black phyllites in the neighbourhood of the meta-basalt. Some of the hornstones contain disseminated pyrite and/or arsenopyrite, and a little gold. From the evidence of sections across the contact of the Birrimian and Tarkwaian rocks there does not appear to be any marked discordance between them, but the relationships are complicated by post-Tarkwaian folding accompanied by thrust-faulting. The pebbles of Birrimian phyllite, lava, and hornstone, in the basal conglomerates and grits of the Tarkwaian, indicate uplift and erosion of some of the Birrimian rocks before, and contemporaneously with, the deposition of the shallow-water Tarkwaian sediments.

The rocks of both the Tarkwaian and Birrimian Systems are highly inclined and dips ranging from 60° to 90° are usual. The dips are steepest in the south of the area and least in the north-east, where the strike of the rocks bends towards the east. In the vicinity of the line of section on the geological map the dips are almost everywhere to the N.N.W. South-east of the Jimi River near Domiabra the sequence of beds is normal but inverted ; upper Birrimian phyllites and calc-chlorite-schists overlie the Kawere conglomerate and grits, and these in

turn overlie the Dampaiyau and Abotenten quartzites and grits. The Jimi River probably follows a fault which brings upper Tarkwaian beds into contact with Birrimian phyllites and lavas. From Abomposo to Domiabra the sequence is also more or less normal, but inverted ; Birrimian rocks overlie basal Tarkwaian grits and Dampaiyauan quartzites, which in turn overlie the chloritoid-phyllites and the Abotenten quartzites. The available evidence indicates that the Tarkwaian rocks occur in a wide overturned synclinal fold, with an overthrusted anticlinal fold, which brings the underlying Birrimian rocks to the surface, in the vicinity of the Jimi River valley. Mine and adit sections, and railway cuttings, show numerous faults which are mostly of the overthrust type. Prominent joints and small transverse faults, which trend E.N.E. to S.E. and mostly dip N.N.E., were noted in several places. Certain topographical features, such as the course of the Nyam Su through the Sansu range, were probably determined by faulting or jointing of this type. The main ore channel from Sansu to beyond Obuasi is a strong zone of shearing and faulting. Similar shear zones have been noted in other parts of the Obuasi district.

The regional metamorphism of the rocks is of a low-grade order characteristic of relatively low-temperature and low-pressure conditions, with zones in which the pressure was much greater than the average. As a result of the metamorphism the argillaceous sediments have been converted into slates, phyllites and sericite-schists, and the arenaceous rocks into quartzites. A ferriferous carbonate having a composition approaching that of ankerite is widely distributed in the Birrimian rocks and is present in the rocks of the Kawere Group. Some of the carbonate was probably deposited with the sediments, but some of it appears to have been formed by a regional metasomatic metamorphism of the rocks. In the vicinity of the lode channels the wall rocks are intensely metasomatically altered. This alteration is superimposed upon those of a regional type.

The most interesting metamorphic changes in the igneous rocks are illustrated by the large sill or dyke of gabbroidal rocks in the Dampaiyau range. The progressive stages in the breakdown of fresh olivine-bearing gabbro and norite, through uralitic gabbro to calc-chlorite-schist composed of carbonate, chlorite, sericite, albite, and quartz, are to be seen in the field, and in thin sections of the rocks. Analyses of a suite of specimens show that in the change from the fresh rocks to the altered ones, water, potash and carbon dioxide are introduced and soda leached. There is also evidence of a slight but progressive leaching of the lime.

All the auriferous occurrences of any importance are situated in the Birrimian phyllites on the N.W. side of the meta-basalt and associated diabase dykes of the Sansu-Moinsi range. They are probably connected with one ore channel which extends in approximately a straight line from Sansu to beyond Obuasi. This channel is probably part of a much longer gold channel which stretches from near Prestea to beyond Obuasi.

The bedded rocks at the Ashanti mine are metasomatically altered phyllites and sericite-schists after original carbonaceous muds, with intercalated harder bands of fine-grained greywacke and ash. The average strike of these rocks is between N.N.E. and N.E., and the average dip is about 75°. With the exception of the porphyroblasts of ankerite, which were formed as a result of the regional metasomatic metamorphism of the rocks, practically all of the arsenopyrite, pyrite, and ankerite, and a good deal of the sericite and chlorite, in the rocks in close proximity to the lode channels have been formed by the intense hydrothermal alteration caused by the ore-bearing solutions. Silicification of the wall rocks adjoining the reef channels is not a marked feature. The arsenopyrite is almost invariably idiomorphic and the pyrite allotriomorphic, and the latter often coats and surrounds the former. The only intrusive igneous rocks of importance in the Ashanti mine are the bleached and carbonated diabase dykes, one of which forms the foot-wall of the " New Make " at many places in the lower levels, and a dolerite dyke which dips S.S.E. at 75° and cuts across the Obuasi reef, the " New Make," and the country rocks. Post-mineral movements along the walls of the " New Make " at Nos. 18 and 19 levels have crushed the dolerite dyke, and displaced the hanging-wall section of the dyke a distance of 50 to 70 ft. horizontally relative to the footwall section. The diabase dykes were intruded before the quartz reefs were formed.

Many of the ore-bodies occur in persistent deep-seated shear zones, which strike between N. and N.E. and dip at fairly high angles on either side of the vertical plane. The Obuasi shear zone has a curved strike varying from N. 25° E. at the Obuasi south workings to N. 50° E. at the N.E. end of the Ashanti mine. At this end the trend of the shear zone is roughly parallel to the strike of the phyllites, but further to the S.W. it cuts across the strike of these rocks at 10° to 20°. The Obuasi quartz-reef is lenticular in plan and vertical section, and from Nos. 14 to 19 levels it is about 1,300 ft. long and in places as much as 45 ft. wide. The average dip of the reef is 65°–70° N.W. and it pitches to the N.E. in the plane of the lode channel at about 45°. It has been worked over a vertical range of about 2,600 ft.

Branching from the Obuasi channel on the hanging-wall side there are several smaller channels filled with graphitic gouge and/or quartz. The Ashanti reef channel is the main one of these. From the surface to No. 10 level the Ashanti reef forms a continuous body of quartz, 1,000 ft. long at some levels, and having a maximum width of about 40 ft. The reef channel persists to at least No. 23 level and at some of the lower levels lenticular bodies of quartz occur in the channel. The Ashanti reef dips E. to S.E. at about 80° and pitches N.E. at 45°–55°, and cuts across the phyllites in the direction of their dip. It has a curved strike varying from north, near its junction with the Obuasi reef, to N. 40° E. to the north-east. To the south-west of the junction the composite reefs strike N. 32° E. and dip N.W. at about 70°. The channel in which occur the Cote d'Or reef and the " New Make " appears to be an overthrust fault having an average dip of about 45° N.W. In the upper levels the Cote d'Or reef was about 700 ft. long and pitched to the N.E. at about 45°. From No. 18 level to the intersection with the Obuasi fissure at No. 23 level the " New Make " dips at about 30° N.W. and pitches at about 15°–20° to the N.E. In this section it cuts abruptly across the dip of the bedded phyllites. A characteristic feature of the quartz of the " New Make " is its laminated or ribboned structure, caused by parallel partings of lustrous black schist in the quartz.

The lodes in the Ashanti mine consist essentially of quartz with a little ankerite, pyrite, arsenopyrite, sericite, "graphite," galena, pyrrhotite, sphalerite, and gold. Albite is rare. The sulphides and the gold often occur in fractures in sheared and shattered quartz. There are at least three distinct types of vein quartz :—(*a*) Smoky-grey sheared and laminated quartz of the Obuasi type. This kind of quartz carries the bulk of the gold. (*b*) Hard milk-white quartz. This type carries some gold, but is generally of low grade. (*c*) Barren glassy quartz which occurs in small veins filling tension cracks in the quartz of types (*a*) and (*b*). The bulk of the gold is finely divided ; when coarse gold is present it is usually associated with galena and sphalerite. Fully 75% of the gold in the Ashanti mine is free milling, but at Justice's mine the ore-body is a pipe-shaped formation of highly mineralized schist, and below the oxidized zone practically none of the gold is free.

The ores are believed to be of very great age (probably pre-Cambrian) and to have been formed at a considerable depth. The ore-bearing emanations were probably derived from a deep-seated cooling magma, of which the Akrokerri granite, the sodic granite west of Obuasi, and the albite-granite-porphyry near Domiabra, are offshoots. These rocks are rich in soda, and it is noteworthy that in other parts of the Gold Coast auriferous quartz reefs are associated with similar soda-rich granites and granodiorites, and rarely, if at all, with potash-rich granites. It is improbable that the wide quartz reefs filled large open fissures, but some of them may have been formed by repeated enlargements of small fissures. Although some replacement of the wall-rocks by quartz has taken place, the available evidence indicates that the bulk of the quartz was not formed in this way. Many of the very wide reefs are composite, and some of them have been increased in width by post-mineral movements.

In the Ashanti mine the gold occurs in three well defined shoots all of which pitch to the N.N.E. The Ashanti and Obuasi shoots pitch in the same direction, and at approximately the same angle (45°–55°) as the pitch of the junction of the two reefs. Although the three reefs overlap in places when viewed in a longitudinal section, the ore-shoots in general do not overlap. The Ashanti shoot was worked from the surface to a depth of about 1,000 ft. The shoot maintained a length of 850 ft. to No. 7 level but below this level it rapidly tapered and at No. 11 level the reef was tested over a length of 300 ft. but very little profitable ore was exposed. Until recently, the possible extension of the Ashanti shoot in depth had not been tested, but this is now being done from No. 16 level N.E. The Obuasi shoot has been worked from the surface to No 22 level and at some levels for a length of more than 1,200 ft. During the period 1898–1928 the remarkable total of 1,407,000 oz. of fine gold were won from 1,292,000 tons of ore from the Obuasi shoot. The shoot has an average pitch of 45° N.E. ; in general it is richest where the quartz is widest, i.e. near the junctions of the Obuasi reef with the Ashanti and other hanging-wall spurs, and poorest where the reef is narrowest, e.g. near the ends of the quartz lens. Sections of the Obuasi reef in which the dip is less than the average are poorer than the steeper sections of the reef. From about No. 10 level to between Nos. 18 and 19 levels the Obuasi shoot was fairly uniform in size and grade. Just above No. 19 level, however, the values commenced to decrease, and at Nos. 21 and 22 levels the shoot is short and relatively poor. Coincident with this change the hard white Ashanti spur type of quartz became more prominent than in the levels above, and gradually took the place of the typical shattered grey quartz of the Obuasi type.

Great widths of phenomenally rich ore have been opened up at several levels on the "New Make," and particularly at Nos. 20–22½ levels. At No. 21, the richest level, the shoot is 950 ft. long and averages 46·7 dwt. of gold per ton over an average width of 22 ft. The bonanza ore in the "New Make" between Nos. 20 and 22 levels corresponds with the "pinch" in the Obuasi shoot at the same levels, and it is interesting to note that the "pinch" in the Ashanti shoot at Nos. 9 and 10 levels coincided with an increase in values, and a considerable increase in length, of the Obuasi shoot at Nos. 10 to 12 levels. It is believed that the very flat pitch and dip of the "New Make" ore-shoot between Nos. 18 and 23 levels is abnormal, and that, with the steepening of the reef above No. 19 level and below No. 23 level, it is probable that the shoot will also steepen. The ore-shoots appear to have been determined principally by structural features, such as reef junctions and intersections, e.g., the Obuasi shoot and zones of fracturing. It is likely that the gold-bearing solutions followed restricted paths, e.g., small open fissures and shattered zones in the country rock or in previously formed quartz, in which their continuous upward movement was facilitated.

Underground sections and microscope slides show that even where the Ashanti and Obuasi reefs are side by side in the same channel the quartz of the Obuasi reef is much more shattered than the quartz of the Ashanti reef. For this reason it is thought that the Obuasi reef is older than the Ashanti reef. The sequence of events from the formation of the Obuasi and Cote d'Or reefs to the introduction of the gold is probably as follows :—

(*a*) Introduction of quartz, probably accompanied by some gold from deep-seated sources, forming the Obuasi and Cote d'Or reefs.

(*b*) Earth-movements causing shearing and fracturing of these reefs and leading to the formation of the Ashanti spurs.

(*c*) Slightly later than (*b*), introduction of the bulk of the gold and sulphides from a deep-seated source.

Finely-divided amorphous carbonaceous matter is common in the Birrimian phyllites, both in the vicinity of the lode channels and far removed from them. The carbonaceous matter is usually restricted to the bedding planes, and many of the phyllites consist of alternating dark-coloured carbon-bearing layers and light-coloured layers containing very little carbonaceous matter. Pebbles, flakes, and dust of black carbon-bearing Birrimian phyllite occur in the Kawere conglomerate and in the grits and quartzites near the base of the Tarkwaian System, and in certain localities there is a progressive change in the colour (from white to black) of these lower Tarkwaian sediments as the base of the System is approached. It is clear that the carbonaceous matter was formed before the deposition of the Tarkwaian sediments, and that the black Birrimian phyllites were originally carbon-bearing muds. "Graphitic" gouge and breccia composed of rounded and ellipsoidal cobbles of

vein quartz and the wall rocks, which are slickensided and coated with shining black carbonaceous matter, in a matrix of finely comminuted friable black schist debris and quartz, are strongly developed in the main lode channels in the Birrimian phyllites, but also occur to a smaller extent in fault channels in which no lodes are known to exist. Analyses show that the percentage of carbon in the gouge and wall rocks of the Obuasi channel—normally between 1% and 4%, and rarely more than 6%—is less than is suggested by the appearance of the material. The percentage of sulphur varies with the percentage of carbon in many cases, but in general there is no apparent inverse relation between the amounts of carbon and carbon-dioxide. There is a greater concentration of carbon in the Obuasi channel than in the foot-wall rocks but there are indications that the hanging-wall gouge and wall rocks contain more carbon and sulphur than the corresponding footwall gouge and wall rocks. The bulk of the carbonaceous matter associated with the lode channels is residual from the mashed carbon-bearing Birrimian phyllites, but a small proportion of the carbon in the phyllites may have been dissolved by the ore-forming solutions and deposited in the lode channels.

WESTERN AUSTRALIAN METALLURGY

Recent improvements in metallurgical practice in Western Australia are described by B. H. Moore in the *Chemical Engineering and Mining Review* of Melbourne for May 5, the article giving the substance of a paper read before the W. A. Branch of the Australian Chemical Institute. Full extracts of the author's paper are given in what follows. He says that among the most important improvements introduced in Western Australia in the metallurgy of gold has been the application of flotation to the treatment of Kalgoorlie and Wiluna ores. At the outset, stress must be laid on the fact that flotation is purely a concentration process and that, although it has been successfully applied for many years in the concentration of base metal ores, its introduction into the treatment of gold ores is of comparatively recent date. Although it is very commonly spoken of as the "oil flotation process," that name is nowadays somewhat of a misnomer, as in many cases the tendency in practice is towards the use of continually diminishing quantities of oils and the use of continually increasing varieties of chemical reagents, so that the process which is now more dependent on chemical reactions for its success should more properly be referred to as "flotation," or "froth flotation."

Before considering the application of flotation to the concentration of gold ores the author considers it advisable to touch on the fundamental principles and the factors exercising an important effect on the flotation of sulphide ores generally. One of the most satisfactory definitions of flotation, he says, is given by Weinig and Palmer (Trend of Flotation) which is as follows :—"It consists in the agitation of finely divided ore in water containing bubbles of air or gas, a small amount of oil and, usually, other reagents, soluble and insoluble; under these conditions the small particles of native metals, sulphides, arsenides, antimonides, selenides and tellurides show a tendency to attach themselves to the films of the bubbles and are thus carried to the surface of the water. The oxidized gangue minerals, such as quartz, felspar, limestone, hematite, etc., show much less affinity for the bubbles, are easily wetted by the water and either remain in suspension in the water or sink to the bottom of the vessel. If the bubbles are sufficiently stable they can be removed, carrying their load of sulphide mineral particles with them. Thus there can be effected a separation of the two classes of minerals from each other, assuming that the grinding has been sufficient to unlock all of the particles of different composition. The separation does not depend on differences in specific gravity of the various minerals; in fact, the sulphides are usually heavier than the oxides, and some of the heaviest sulphides are the easiest to float. A particle of mineral may be so large, however, that its weight will counteract its affinity for the film of the bubble. In most cases the ore must be fine enough to pass a screen having at least 48 meshes to the linear inch."

The active agent in flotation is therefore the bubble and the two main requisites for flotation are bubble or froth formation and selective action of the bubble for sulphide mineral in preference to gangue. The formation of a stable bubble froth capable of carrying the mineral load is effected by the use of suitable oils, which, by diminishing the surface tension of the water, assist in the formation of stable bubbles. The selective action of the bubble film is due to the fact that the surfaces of the sulphide minerals are water-repellent, and therefore are not wetted or filmed with water but are filmed with oil, whereas the oxidized gangue minerals are water-avid or oil-repellent, and therefore are wetted by the water and sink under their own weight. The sulphide minerals are buoyed up by the dense froth of sulphide which must be stable and sufficiently strong to carry the load, and, therefore, as the film of a small bubble is thicker and stronger than that of a large bubble, the formation of a froth of small bubbles is desirable in most cases.

A second factor of vital importance for successful flotation is the necessity for grinding to such an extent as to unlock the mineral particles from the gangue particles. If the ore is ground so fine that the whole of the sulphide mineral particles are unlocked from the enclosing gangue, it should be theoretically possible to make a complete separation of the sulphide minerals from the gangue. In many cases this complete unlocking of the sulphide particles necessitates such extremely fine grinding as to be outside the economic limit of grinding, that is to say, the extremely fine grinding necessary in such cases is so expensive that the advantage gained in extraction is more than counterbalanced by the additional grinding cost, and therefore such grinding is not economically possible. The Wiluna ore furnishes an instance of this kind, as the auriferous mineral, the arsenopyrite, is so fine that grinding to minus 200-mesh fails to unlock the mineral completely from the gangue. In the case of the Kalgoorlie ores such fine grinding is not usually necessary, and in most cases grinding to minus 150-mesh is sufficient to enable a satisfactory commercial extraction to be made.

Fine grinding must be carried out wet because of the tendency for superficial oxidation of the sulphide minerals to take place during dry grinding, mainly on account of the rise in temperature produced during dry grinding. The formation of such oxide films tends to diminish, if not to destroy completely, the floatability of the sulphide minerals and to bring them into the category of the non-floatable oxidized minerals. Similarly, on account of the detrimental effect of these oxide films on the flotation of sulphide minerals it is essential that an ore for flotation treatment must go to the mill in a freshly broken state as soon as possible after being broken out in the mine, and not be held in the stopes or in surface dumps for long periods, where it is subjected to atmospheric oxidation.

Since the production of a firm and stable froth is necessary for flotation, and as this condition is best attained by the use of suitable oils, the reagents used for this purpose, which are for the most part distillation products of wood or coal, are called frothing agents. Among the more commonly used frothing agents are steam distilled pine oil in America and its equivalent, eucalyptus oil, in Australia, and various tars and tar oils and derivatives. To be of use as a frothing agent the oil or other reagent must be partly soluble in water, so as to diminish the surface tension of the water.

From a chemical aspect the various additional reagents used in flotation may be grouped according to their action on the sulphide or gangue minerals, i.e., in promoting or retarding flotation and also according to their behaviour in bringing about in the flotation pulp conditions which are favourable or otherwise to flotation. So far as the action of these reagents on the sulphide minerals is concerned they may be classified as promoters or as depressants in so far as they assist or retard flotation. Promoters are also called collectors and the commonest of this class are the alkali xanthates and various other compounds containing sulphur, such as thio-carbanilide, phosphocresylic acid (aerofloat). These compounds react chemically with the sulphide minerals, the alkali xanthates in particular producing films of xanthates of the metals, which are more readily floated than the sulphides themselves and therefore increase the floatability of the latter. Depressants, on the other hand, act in the opposite direction, producing in most cases, on the sulphide minerals films of oxides or basic compounds of the metals which more or less completely prevent flotation. Good examples of this class are the alkali cyanides and lime which act as depressants of pyrite, and alkali cyanide and zinc sulphate which depress blende by forming a film of zinc cyanide. In some cases of this kind reactivation of the sulphide mineral is possible by the use of special reagents, e.g., in the selective flotation of galena and blende, the galena having been floated and the blende depressed in a pulp to which sodium cyanide and zinc sulphate have been added, the addition of copper sulphate to the pulp after flotation of the galena reactivates the blende which can then be satisfactorily floated.

Other factors to which particular attention must be paid are the consistency of the flotation feed which, to prevent irregularities in flotation, must be kept as nearly as possible constant. For Kalgoorlie ores it has been found that success can be readily attained with a feed containing one part of solids to five parts of water, although similar extractions can be obtained with thicker pulps, but at the expense of the production of a larger quantity of lower-grade concentrate containing much greater proportions of the gangue minerals. Slight variations in the alkalinity of the pulp appear to have no serious effect on flotation and we have found that a pH of 8–8·5 is perfectly satisfactory. An acid pulp is out of the question on account of the presence of a considerable proportion of carbonates in the ores.

The history of flotation in Western Australia is of interest as showing the amount of experimental work that has been carried out before operating companies were convinced that flotation was not only possible, but could be applied with advantage. Prior to 1923 very little experimental research had been carried out on the flotation of pyritic gold ores, nor was much information available in the literature of flotation regarding the flotation of pyrite which was regarded as one of the more difficultly floatable minerals, and the flotation of which the base metal flotation operator always endeavoured to prevent. When the metallurgical laboratory was established at the Kalgoorlie School of Mines in 1923, a detailed investigation of the flotation of Kalgoorlie ores was commenced, during the course of which ores from all the producing mines of the Golden Mile were exhaustively tested. At that time acid flotation circuits were commonly used, but the presence of calcite and other carbonates in the Kalgoorlie ores rendered the use of an acid pulp out of the question on account of the very high consumption of acid necessary to decompose these minerals, in most cases over 100 lb. of sulphuric acid per ton of ore.

At this time, also, promoters, such as the xanthates, had not been introduced and considerable difficulty was met with in determining suitable flotation conditions and reagents. It was found also that the carbonates floated readily in preference to the pyrite and means had to be devised to prevent this from taking place. After experimenting with many reagents for this purpose, common salt was found to be the cheapest and most efficient inhibitor of the flotation of the colloidal carbonates, and at the same time was found to have no detrimental effect on the flotation of pyrite. By making use of a combination of flotation reagents, such as eucalyptus oil, pyridine, and coal tar it was found possible to float satisfactorily the auriferous pyrite in all the Kalgoorlie ores, although in some cases the use of salt water was unnecessary. It was found that a satisfactory combination of flotation reagents consisted of eucalyptus oil, crude pyridine and coal tar, but these reagents were added in the form of a mixture on account of the difficulty of emulsifying the coal tar if added separately. In the early stages of this investigation when eucalyptus oil alone was used as a frother it was found possible to produce a small quantity of a very rich froth containing practically no pyrite, but that the pyrite itself was particularly difficult to float. This froth consisted, for the most part, of the carbonates of calcium and magnesium with the minute amounts of the gold tellurides present in the ore. At this time the object in view was the flotation of the whole of the gold-bearing minerals and the significance of this fact was not specially considered.

Reference is made later to this phenomenon of which use was made during an investigation into

the bromocyanidation of Kalgoorlie ores. When reference was made in the technical press to the application of xanthates to flotation, a small quantity of potassium ethyl xanthate was procured from America, and its promoting effect was found to be so great that it was subsequently used in all test work with eucalyptus oil or coal tar oil as a frother. In all this experimental work it was found possible, after suitable conditions had been determined, to float any of the Kalgoorlie ores successfully, producing a concentrate averaging about 12·5% of the ore and showing an extraction of well over 90% of the gold. Experimental work on a larger scale in the pilot plant erected by Oroya Links Ltd., both by the company's metallurgists and by the school of mines staff, confirmed the conclusion arrived at from the laboratory research that flotation could be successfully applied to the treatment of Kalgoorlie ores.

Subsequently, the school of mines, at the request of Mr. H. E. Vail, consulting engineer for Wiluna Gold Mines, investigated also the flotation of Wiluna ore, when it was found that successful flotation could be achieved by the use of similar methods to those employed for Kalgoorlie ores, but that successful flotation was impossible except in salt water and that concentrations of sodium chloride up to 15% were in no way harmful. This latter point was investigated because the mine water at Wiluna contains approximately 14% NaCl. The Wiluna company erected a pilot plant and carried out extensive tests, as a result of which the installation of an all-flotation plant was decided upon and this plant came into operation early in 1931. Lake View and Star, Ltd. have also introduced flotation and have now modified their plant to all flotation with satisfactory results both as regards extraction and treatment costs.

In connexion with the flotation of these ores, the roasting and cyanidation of the concentrates have also been investigated, and it has been shown conclusively that the concentrates can be successfully roasted without the use of extraneous fuel, except for initially heating up the furnace to the roasting temperature and that cyanidation of the roasted concentrates presents no difficulties. The important factor in the roasting, however, is that roasting must be carried out at a low temperature until the first atom of sulphur in the pyrite is oxidized, after which the temperature may be raised without harmful effect. These improvements in treatment, which have enabled treatment costs to be reduced to about 7s. per ton, have rendered available large quantities of low-grade ore which could not be profitably mined when all roasting treatment, with its high operating cost, was practised. The author understands that at Lake View and Star, Ltd. the results of flotation have been quite satisfactory and that 2s. flotation tails are being produced from 33s. heads. At Wiluna, however, where, as previously stated, conditions are different on account of the necessity for extremely fine grinding to unlock all the auriferous mineral, results are satisfactory, although the company has to be satisfied with a lower extraction by flotation, the over-all extraction at the present time being about 83%.

The successful application of flotation on a large scale is a source of gratification to the metallurgical staff of the school of mines who have consistently and, in the face of much adverse and hostile criticism, claimed that flotation was capable of yielding as high an extraction of gold as the all-roasting process which has been in use for so many years, and that its introduction would result in a substantial lowering of treatment costs.

Another improvement in metallurgical practice is the reintroduction of bromocyanidation which will be applied shortly in a new plant now in course of erection by the Boulder Perseverance Co. In 1926, Mr. C. E. Blackett, who had had many years' experience of bromocyanidation while metallurgist on the Golden Horseshoe and had subsequently been appointed research metallurgist on the Boulder Perseverance, investigated anew the bromocyanidation of Kalgoorlie ores and of flue dust from the roasters. In the course of this investigation, Mr. Blackett found that, by the use of this method of treatment, it was possible to secure an extraction of over 90% of the gold. Although this process had been used to a considerable extent with varying success in the early days of Kalgoorlie it was discarded in favour of the all-roasting process. The results obtained by Mr. Blackett were so encouraging that, when they were submitted to the state mining engineer, the author was instructed to confirm the results. In consequence a detailed investigation was undertaken, as a result of which it can be stated that a satisfactory extraction can be obtained provided that the necessary conditions are carefully regulated during treatment. In its essential conditions, this modified method differs but little from that in use previously, although the introduction of modern fine grinding machines makes possible the very fine grinding—at least to minus 200-mesh—necessary for this process, which is purely a chemical process. The main conditions to be observed in the process are fine grinding wet to minus 200-mesh, agitation for two hours with cyanide solution, followed by the addition of 1 lb. of cyanogen bromide per ton of ore and continued agitation for one hour, after which sufficient lime is added to produce the necessary alkalinity for precipitation, and the charge is then filtered. Apart from the fine grinding, the important feature of the process is that at the time of addition of cyanogen bromide the alkalinity of the solution should not exceed 0·002% CaO, and therefore careful regulation of the lime addition before the preliminary agitation with cyanide solution is essential.

If this process can yield as good an extraction as flotation and roasting and cyanidation of flotation concentrates, treatment costs will apparently be about the same in both cases, but the bromocyanide process will have the advantage of requiring a simpler and smaller plant for treatment of the same tonnage, and therefore the capital cost will be much less. It suffers, however, from the disadvantage that very careful chemical control is necessary, which cannot be delegated to unskilled employees.

In connexion with bromocyanidation it may be advisable to point out that it has long been considered that, from most of the Kalgoorlie ores, an extraction of over 60% of the gold could be obtained by plain cyanidation and that additional methods of treatment were necessary to extract the greater portion of the remaining gold. In endeavouring to decide this point the author tried to separate the telluride minerals from the sulphide minerals in order to determine whether the latter were amenable to plain cyanidation. Use was made of the fact, previously mentioned, that a small quantity of very rich concentrate containing very

little sulphide could be obtained by flotation when using a frother without a promoter. In addition, it was found that similar results could be obtained without the use of a frother, in which case the colloidal carbonates themselves, in conjunction with the violent agitation, produced the rich froth, and also that the results were practically the same whether or not a pyrite depressant was used. In this connexion, of course, cyanide was out of the question as a depressant, and it was found that tannic acid was extremely efficient. Having produced this rich concentrate, which was found, on analysis, to contain practically all the tellurium present in the original ore and a percentage of pyrite approximately the same as that of the original ore, the two products were subsequently treated separately. The concentrate was treated by bromocyanidation with excellent results, and the flotation tails by plain cyanidation, also with excellent results. Hence it is apparent that only a very small percentage of the ore requires special treatment and that by segregating the tellurides in this way a simple and comparatively inexpensive method of treatment might be developed, since an elaborate flotation unit is not necessary and the proportion of rich concentrate produced is so small that the quantity of expensive cyanogen bromide used would also be very small. In addition, this rich concentrate consists of the more brittle mineral constituents of the ore, namely, the tellurides and carbonates, and the extremely fine grinding necessary for all-bromocyanidation would not be required if this combined method of treatment were adopted.

A plant is now in course of erection by Boulder Perseverance Ltd. to treat 6,000 tons per month by bromocyanidation, and the results obtained after the plant is in full operation will determine whether flotation or the modified bromocyanidation process is the more efficient of the two most recent improvements in metallurgical practice introduced in Western Australia.

REFRACTORY CEMENTS

In *Chemical and Metallurgical Engineering* for June, W. R. Kerr deals with the types, uses, and testing of refractory cements. The author considers that refractory cements may be classed as mixtures ordinarily used for bonding and coating firebrick walls. At the present time there are a large number of brands on the market which are designed to fit various refractory applications and are recommended for use all the way from a dull red heat up to temperatures in excess of 3,000° F.

Refractory cements of the present time are of many different compositions. Basically, however, most cements are similar in that they contain clay and grog. A certain quantity of raw plastic clay or kaolin adds plasticity and renders the cement workable. In addition to the raw clay, the cement usually contains a variable quantity of grog (crushed brick, refractory mineral aggregate, ground saggers, etc.). This grog component, in most cases, is the refractory substance in the cement, and aside from building up the refractoriness of the body, it is of material benefit because it reduces the drying and firing shrinkage.

The basic formula of clay plus grog may be modified in several ways to produce suitable mortars for laying and coating certain types of firebrick. By using a highly siliceous grog such as ganister, a cement may be made adaptable to silica brick. Ground chromite used as grog produces a chrome-base cement which is desirable for certain conditions in furnaces. Then again, certain fluxes such as felspar, ground glass, mica, and so on, may be added to the clay-grog body in order to lower the fusing point and cause the cement to form a semi-glaze on the surface to which it has been applied.

Air-Setting Cements.—All of the combinations mentioned above may be further modified by the addition of a cold bonding agent which, upon drying, will set or harden so as to act as a binder for the mass. Such binders are commonly liquid sodium silicate, dry sodium silicate powder, dextrine, molasses, or some other substance which sets upon drying. These binders may be added to the cement in wet form and sold ready mixed, as is the case with many cements. The alternative manner of adding the binder is to make a dry mixture of the bond and cement ; it is then only necessary to mix the dry cement with water on the job. Air-setting cements have been developed on account of the need for a strong joint in the brickwork. Certain heavy structures require a stronger bond than is produced by fireclay alone, and the cold-setting cements have filled this need. In the case of organic binders, such as dextrine, the original strength obtained when the cement sets is lost when the cement is fired, and the bond must then be developed by the action of heat. The inorganic binders, of which sodium silicate is by far the most common, do not lose their strength to such a great extent upon moderate heating, but aid in the development of the bond as the cement is heated during firing of the brickwork.

The grade of sodium silicate used in refractory cements is quite important. While most of the liquid grades produce a firm cold bond, the behaviours of the various grades under heat are quite different. A grade having a ratio of soda to silica of 1 : 2·4 has been found to be satisfactory. If a grade which contains more silica is used, the strength decreases more rapidly with a rise in temperature, while if a more alkaline silicate is used, the fusion point of the cement is lowered by too great an amount and the air-setting properties of the material are retarded.

High-Temperature Bonds.—Refractory cements which depend on the action of heat for the development of a bond are used where a cold-set bond is not necessary. Such cements are useful in providing a cushioned joint which allows some expansion and contraction where the bond is not set up hard by the action of heat. This class of cement usually includes the more refractory types, which are recommended for extremely high temperatures (above 3,000° F.), since the absence of fluxing agents prevents lowering the melting point and permits the cement to be used at high temperature. Many compositions are offered by the manufacturers to fill the needs for different types of cements. For silica brick, a cement usually is recommended which has a silica base. Chrome-base cements are useful where a chemically neutral condition is desirable. The clay-grog mixtures are used quite commonly in laying up firebrick, in almost all types of furnaces where moderately

severe conditions are encountered. During the past few years there have appeared on the market a number of so-called super-refractory cements which contain more refractory substances as a base. Some of these are chromite, calcined diaspore, mullite grain, silicon carbide, alumina and sillimanite.

Grain size of the grog particles in the cement affects the workability of the cement. The finer the grind, the better is the workability, although the shrinkage is somewhat increased by excessive reduction of the fines. In three satisfactory ready-mixed cements recently examined, all the grog passed a 28-mesh (0·0232-in.) sieve and approximately 50% of it passed a 200-mesh sieve (0·0029 in.). This shows the extent to which the fineness of grog can be extended and still give a satisfactory product. Most cements will pass a 20-mesh sieve.

Use of Cements.—The most successful applications to which any given cement can be put are best determined by its characteristics. Some of the more common uses are as a bond in setting brick; in wash-coating or spraying a protective facing over finished walls; and as a patching mixture for eroded or spalled brickwork. Air-setting cements are commonly used to repair broken saggers or special refractory shapes such as kiln-car tops. Shapes can frequently be repaired a number of times, greatly prolonging the life of the equipment and decreasing the maintenance cost markedly.

In setting firebrick, the usual methods employ either a buttered joint tapped in place with a hammer, or a dipped joint which is rubbed in place. The dipped joint usually is preferred because, as pointed out by Harvey, the dipped surface makes better contact with the cement than does a surface on which a coating of cement has been trowelled. This method is well adapted for laying up brickwork with very thin joints. It is more rapid than other methods and hence a saving in labour is effected. Dipped joints should be laid by dipping the brick into a batter of the cement which has been thinned with water to a cream or soup consistency, and then rubbing or tapping the brick into place.

Protective coatings of refractory cement are of value on new brickwork. The coating can be applied either by brush or spray. In any case it is best to apply it with cement which has been thinned to a creamy consistency. For a brush coating the brickwork should be blown free of dust, after which the cement is brushed on with a stiff brush or a broom, working it into the pores. An equally effective coating can be applied by spraying with a cement gun. This latter method is rapid, and even coatings can be applied. A home-made gun is suitable for most cements, but special pieces of apparatus are available for more rapid handling of the mixture. Protective facings are of value where there is a tendency to clinkering, provided the cement is refractory enough. A properly applied facing offers some protection against erosion by high-velocity gases and tends to retard disintegration of the refractory by action of furnace gases; it also tends to render the brickwork gas-tight. Whenever coatings are applied, they should be as thin as is consistent with the protection offered, since thick coatings frequently have a tendency to chip and peel away from the wall.

Desirable Properties of Cements.—When refractory cements are to be selected for any of the applications listed, there are several general specifications which should be regarded in making a choice:

1.—The cement should be of such a chemical nature that it will not react with the refractory at elevated temperatures. It should be inert chemically to the action of furnace gases and be resistant to slag attack.

2.—Drying and firing shrinkage should be low. Excessive firing shrinkage causes the cement to peel from the wall.

3.—Cement should have a refractoriness at least equal to the brick with which it is used.

4.—The coefficient of expansion of the dried cement should be low or, rather, it should be practically the same as that of the wall to which it is to be applied. Differential expansion causes cracking and peeling with ultimate failure.

5.—Cement should be workable, so that the labour costs may be kept as low as possible.

6.—If an air-setting cement is used, it should set firm within a few hours. If the cement has a tendency to creep and set slowly, the brickwork may settle when additions are built upon it.

Testing of Cements.—Some of the more important of the desirable properties of a cement are refractoriness, freedom from cracking, low shrinkage, and service under load at definite temperatures. The refractoriness is easily found by the standard method for determination of p.c.e. (pyrometric cone equivalent). Wet cements should first be calcined.

Cracking and shrinkage can be observed by brushing or trowelling layers of cement of various thicknesses on brick, and after allowing them to dry, heating to a definite temperature. Another method long favoured by one company that tests cements frequently is to trowel or slick a wedge-shaped coating of cement on the face of a brick. The wedge usually tapers from zero at one end of the brick to about ¼ in. at the other. Upon drying and firing the sample, it is possible to gain an idea of the approximate thickness which can be applied safely in practice before cracking or excessive shrinkage appears.

The behaviour of the cement with a certain grade of refractory, under definite conditions of loading and temperature, is easily determined by constructing a suitable pier of half brick bonded with the cement to be tested. These piers are conveniently made in sandwich form, bonding either three or four half brick with cement, using joints approximately ¼ in. thick. The pier, when dry, is set in a suitable testing furnace and loaded to a predetermined figure. The temperature is then raised to simulate a service condition and after an interval of time the pier is allowed to cool and is examined. This test reveals any tendency for the cement to react with the refractory under pressure and also the resistance of the cement to load at the temperature used.

Testing of refractory cements is an item not to be overlooked. Unfortunately, all cements do not behave alike, and it is sometimes found that one product will give good service where another has failed. The writer has in mind three test wash-coatings recently applied to a test furnace. The most expensive coating cracked and peeled badly after three heats. The second coating was fair, while the third coating lasted through a dozen heats until the furnace was torn down, without any more serious failure than a few surface cracks.

DURALUMIN SKIPS

In the last issue of the MAGAZINE some account was given of the increasing use which is being made of duralumin skips and cages in South Africa. In a paper read before the South African Association of Mine Resident Engineers in April last, W. H. Mitchell gave some operating details obtained during the use of duralumin equipment on the Randfontein Estates and extracts from his paper are given here. Speaking of the properties of duralumin alloy, he says that the conspicuous physical property possessed by this alloy of aluminium is its high tensile strength. It possesses a breaking strength about three times as great as mild steel when considered weight for weight. It is stated that duralumin attains its high strength by virtue of a special process of heat treatment and ageing. The metal can be turned and machined, takes a high polish, and also offers a marked resistance to corrosion.

PERFORMANCE OF STEEL AND DURALUMIN SKIPS.—There are various aspects to be considered when comparing the performance of duralumin and steel skips from the point of view of output of tons of ore. A clear conception of the conditions and the gain resulting from a duralumin installation can be best understood by considering—(*a*) A similar number of trips ; and (*b*) A similar tonnage hoisted ; to a steel skip equipment.

Working on the supposition that duralumin and steel skips hoist from the same depth, the rock hoisted in a given time will be in favour of duralumin in the proportion of 7–6 for a similar number of trips. This indicates 16·6% increase in tonnage, assuming the mining conditions underground permit of this extra tonnage being dealt with. It is an extremely difficult matter to arrive at a definite monetary gain resulting from this increased tonnage, since many extraneous and variable factors influence working costs ; but it can be stated that in the case considered the installation permits of 16·6% more tonnage to the mill, and consequently the profit earning capacity of the shaft is increased in a given time.

In the case of a mine which cannot or does not desire to increase its underground equipment to deal with more tonnage, then the contrast between duralumin and steel skips must be on a similar tonnage. For duralumin skips to yield a similar tonnage then the performance can be done in 16·6% less time. Economies in winding rope are naturally affected since a reduction of 16·6% in the running time occurs, which materially adds to the useful life of the rope. The saving in power is also 16·6% since less trips are run. An increased hoisting depth can be attained without exceeding the prescribed factor of safety.

In the particular case considered above the benefits certainly seem justifiable enough to merit the installation of a duralumin equipment.

ACTUAL OPERATING CONDITIONS.—In practice the cases considered above are seldom realized to the extent of forming comparisons in the theoretical manner adopted. Comparative figures from a section do not indicate similar trips or a similar tonnage hoisted, the only fair method is to contrast the power input and foot-tons of useful work performed, and the ensuing portion of the paper is devoted to a consideration of the performance and operating characteristics of duralumin and steel equipments over two main mine sections of the Randfontein Estates designated by the letters A and B respectively.

DURALUMIN EQUIPMENT.—The duralumin equipment installed at the Randfontein Estates consists of :—

Steel runner bridle frame, which is similar to the steel skip frame.

0·4 Carbon steel wearing plates.

Steel crosshead and king bolt as used for steel.

Steel retaining hooks operating in roller bearings.

Steel rocker shaft.

Duralumin ore pan.

Duralumin cross-bar on base of steel bridle frame.

Duralumin rocker shaft bearings lined with white metal.

The duralumin ore pan is lined with manganese plate on the sides to minimize abrasive action of the rock. Bullet proof steel has been tried for this function, but experience proved that it tended to crack. It is intended in the future to obtain a steel lining with the requisite hardness to resist abrasion and to withstand cracking. The base of the ore pan is lined with " Linatex " rubber approximately 4 in. in thickness. Its function is to throw out any deposit that may adhere to the bottom of the pan when it is tipped. The inherent resilience of the rubber causing the deposit to be tipped. The cushioning effect on the base of the pan by the Linatex rubber has brought about less structural strength required. Linatex guard pieces are placed in close proximity to the retaining hooks to prevent spillage interfering with their action.

The rocker shaft is now one foot lower from the top of the pan, necessitated by the increased depth of ore pan to accommodate one ton of extra ore. The ore load is now 7 tons as against 6 tons carried formerly by the steel pan.

COMPARATIVE LOADING OF DURALUMIN AND STEEL EQUIPMENT.—The figures given below indicate the loading in the case of duralumin and steel equipment. The skip is to be regarded as consisting of ore pan, steel bridle frame and other appurtenances.

	Duralumin.		Steel.	
	Up. lb.	*Down.* lb.	*Up.* lb.	*Down.* lb.
Skip . .	7,985	7,985	10,430	10,430
Contents . .	14,000	—	12,000	—
Rope . .	24,000	—	24,000	—
Load . .	45,985	7,985	46,430	10,430

The upcoming pull on rope is reduced by 445 lb. for duralumin skips.

The downgoing pull on rope is reduced by 2,445 lb. for duralumin skips.

The force lost operating in balance is then 2,000 lb. in the case of duralumin equipment, as compared with a steel equipment.

Acceleration.—Comparing the duralumin and steel skips from the point of view of statical balance, that is, when skips are freely suspended—one fully loaded and the other skip out of the tipping path—a force of 2,000 lb. is lost on the duralumin. This would seem to indicate a larger accelerating torque imposed on the hoist with duralumin skips, but if one considers the case when the torque on the engine is a maximum with one skip in the tip the out-of-balance force of 2,000 lb. is not so appreciable as

one would imagine. At the initial moment of starting the wind, the skip in the tip contributes little to helping the engine torque, either in the case of duralumin or steel skips.

The largest vertical force acting at the moment of starting is due to the steel bridle frame, and since this is the same for the duralumin and steel skips the accelerating torque of the engine for the first two to three seconds of starting is little affected by the loss in weight of the duralumin skip. The upcoming load, however, is reduced by 445 lb. so the maximum torque exerted by the engine for the first 2 to 3 seconds, while the downgoing skip is gradually coming into the vertical position from the tip, would seem to indicate less power required at the commencement of the wind. Under operating conditions no appreciable increase in power required at the initial moment of starting was observed on the ammeter, as compared with observations taken with the steel equipment.

Retardation.—Since all moving masses are now reduced the power required for retardation in the mechanical and electrical sense is reduced, although no appreciable indication of such is shown on the ammeter. The current variations during the winding cycle being practically similar to that for steel skips from observation and reports from the engine drivers concerned.

The series of figures representative of six months operation with duralumin and steel equipments over two of the main mine sections are given, and it is shown that a decrease in the electrical consumption occurs, bearing out the statement that less power appears to be taken by the duralumin during acceleration and retardation periods. The actual saving in power consumption and also the effect on the hoisting efficiency show the benefits obtained since the installation of the duralumin skips.

Power Consumption for Steel and Duralumin Equipments.—The hoists on the two sections considered are each 5,000 h.p. and operate on the Ward Leonard system, with Brown Boveri phase advancers. Since the ore is hoisted from different levels, the useful foot-tons of work performed is contrasted with the electrical input for the duralumin and steel equipments respectively for a period of six months. Useful load is considered as rock load only. The cost of an electrical unit is taken as 0·25 pence. It is shown that, on the B section :—

The average cost per 1,000 ft.-tons of useful rock load hoisted (steel skip)	0·425 pence
The average cost per 1,000 ft.-tons of useful rock load hoisted (duralumin skip)	0·400 ,,
The saving effected by duralumin skips on 1,000 ft.-tons of useful rock load hoisted	0·025 ,,
The saving effected by duralumin skips on 2,317 million ft.-tons of useful rock load hoisted	£240
The average annual saving in electrical power	£480

The increase in ft.-tons with duralumin is 199 million or 9·4%.

The increase in units consumed with duralumin is 117,400 million or 3·3%.

This indicates a large increase in ft.-tons with a relatively small increase in electrical consumption in the case of duralumin skips and this necessarily must indicate a decrease in the cost of electrical units per 1,000 ft.-tons of useful rock load.

On the A section :—

The average cost per 1,000 ft.-tons of useful rock load hoisted (steel skips)	0·437 pence
The average cost per 1,000 ft.-tons of useful rock load hoisted (duralumin skips)	0·394 ,,
The saving effected by duralumin skips on 1,000 ft.-tons of useful rock load hoisted	0·043 ,,
The saving effected by duralumin skips on 2,791 million ft.-tons of useful rock load hoisted	£500
The average annual saving in electrical power	£1,000

The increase in ft.-tons with duralumin is 586 million or 24·3%.

The increase in units consumed with duralumin is 457,840 million of 11·6% thereby necessitating a decrease in electrical consumption per 1,000 ft.-tons useful load hoisted as given.

Shaft Horse Power and Efficiency of Hoisting.—Comparative figures are given in the paper indicating the changes in hoisting efficiency for the steel and duralumin equipments, respectively.

Under the actual operating conditions at Section A the benefit of increasing the load of ore per trip is rather difficult of estimation, since a number of variable factors complicate matters. It is quite conceivable that with the extra ore hoisted, the extra cost to mine it and ultimately to reduce it, necessitates expenditure, and this at once introduces a host of variable cost figures, from which it is practically impossible to assess any specific monetary gain due to the duralumin skips alone. Considering, however, Section A, which has about reached its maximum output that could be safely hoisted, the following are indicative of what increase in tonnage milled has been effected since the installation of the duralumin skips.

Tons of ore sent to mill :—

Steel skips six months operation	453,000
Duralumin skips six months operation	498,000

It is thus seen on these figures that 45,000 tons of extra ore has been sent to the mill, which represents £11,250 if one assumes a tentative value of 5s. per ton profit. The annual average profit being in the region of £22,500, which will be increased when the conditions underground permit it. It is inferred that the profit earning capacity of this shaft has increased by the use of a duralumin equipment.

Increased Depth and Factor of Safety.—In the case considered at Section A the pull on the rope was reduced by 445 lb., representing approximately 87 ft. of extra hoisting depth. (Rope 5·1 lb. per ft.) If the future development of the shaft demands a greater depth to hoist from, then considerations would arise of whether the hoist is capable of exerting the increased torque demanded or if the ultimate strength of the rope in relation to the total weight on it, would conform to the prescribed factor of safety. In each of the cases quoted a solution is offered by using a duralumin equipment, since, if the same rock load is hoisted as was formerly with steel skips, a saving of 2,445 lb. is effected, giving thereby an extra hoisting depth of 480 ft. without any alteration in the power equipment or increase in the size of rope.

Duralumin Man Cages.—The application of duralumin to mining equipment is very pronounced when applied to man cages, a saving of 2,400 lb. being effected in a two-decker cage capable of carrying 40 men. The reduction in the weight of

this equipment allows, if necessary, increased capacity for man carrying, or alternatively, the saving secures a longer life for the hoisting rope owing to the increase in the factor of safety employed. Considering the cost of renewing these ropes, which in the case of very deep shafts is extremely high, the effect of this economy can be readily appreciated.

The man cages installed at one of the sections on the Randfontein Estates are operated by a steam hoist. They consist essentially of duralumin metal with steel guide frames.

Acceleration.—Since the resultant torque on the drum is the same for the duralumin and steel cages respectively, when operating in balance no benefit accrues from the duralumin cages during the acceleration period.

Retardation.—In retardation, however, all moving masses have to be stopped, including men, cages, and rope, and since a considerable decrease in weight is effected in the case of the duralumin cages, the total moving masses to be brought to rest are considerably less than formerly, and therefore for the same cyclic time the momentum forces are reduced, thereby imposing less strain on safety appliances and brake paths.

Time Factor.—The lowering of men and materials underground is a very important consideration in a shaft, and the allocating of time to lower materials becomes a serious problem which can be eliminated to some extent by duralumin cages. Since 2,400 lb. can be saved in weight about sixteen more men can be carried 'per trip, representing thereby an increase of 40% in the man-carrying capacity of the cage, and conforming to the same factor of safety on the rope. The time to lower the complement of men is then reduced and time for materials and shaft repair is increased. The reduction in the number of trips is also consideraby reduced and a sensible decrease in steam consumption should result.

Hoisting Rope.—Assuming that the trips are less to lower the complement of men underground, a considerable economy on the ropes is effected and when one considers in conjunction with this the considerably reduced dead weight of the man cage it can readily be appreciated how the rope life is extended, which is a factor of great importance in deep level mining.

Running and Maintenance of Duralumin Skips.—Reports on the working characteristics of the duralumin skips show that they are operating in a satisfactory manner, at all sections. The increase in the depth of duralumin pan required to give extra capacity has improved the " turning moment " on entering and leaving the tipping paths thus minimizing wear and tear to the tipping path and the skip. The trip is now performed in a smoother and quieter manner than formerly and less wear on the guide frame and runners occurs.

Cost of Steel and Duralumin Skips.—The cost of a complete steel skip would be about £438, while a complete duralumin skip costs about £813.

Molybdenum.—General 'information in regard to the occurrence, production, properties, and use of molybdenum is given in Economic Paper 15 of the United States Bureau of Mines, by A. V. Petar. The authoress states that molybdenum is a relatively rare element. The United States is fortunate, however, in possessing abundant resources, sufficient to supply not only the needs of manufacturers in that country, but a large proportion of the requirements of European consumers as well. Moreover, molybdenum is the only important special steel-alloying element in which the United States has demonstrated its self-sufficiency. As little as 0·25% of molybdenum is an effective hardening agent when incorporated in alloy steel, and heat-treated steels containing molybdenum are more ductile than many other similar alloy steels.

Pure molybdenum is a silvery white, malleable metal, softer than steel and capable of being filed and polished ; its specific gravity is about 10, or not quite as heavy as that of lead. The metal may be produced in several ways, and its properties vary accordingly. If prepared by the reduction of molybdenum oxides with hydrogen it is a grey metallic powder, which may be compressed under heat and pressure into brittle bars. If the oxide is reduced with carbon an impure grey powder results, of which the specific gravity is about 8·75, due to the presence of carbon. In this form it is harder than quartz. Molybdenum is also manufactured by a chemical process, which gives a dark-blue, metallic, crystalline powder. The melting point of pure molybdenum—about 2,500°—is higher even than that of platinum. Among the metals, only osmium, tantalum, rhenium, and tungsten melt at higher temperatures. Electrically, molybdenum is a good conductor, and it is stronger and harder than copper. It is softer and more easily worked than tungsten. Alloyed with steel it acts much like tungsten, but is more potent. It likewise is very similar to chromium in the properties it imparts to steel, but much smaller quantities are required to produce the desired result.

Molybdenum is consumed principally in the steel industry. Smaller quantities, in the form of wire and sheet, are used as supporting filaments in incandescent lamps and radio valves ; and an additional quantity, in the form of oxide, is absorbed by the chemical industry. Alloy steels containing molybdenum are used in many fields ; they are employed extensively in aircraft and in automobiles. All nitriding steels contain molybdenum and in high-speed steels molybdenum may be substituted for tungsten. It is a valuable addition to rustless, heat-resisting, and acid-resistant steels and to grey-iron castings and steel castings ; it enters into alloy-steel guns and armour plate, saw steels, die steel, razor blades, and countless other products.

Australia, Norway, and the United States have produced most of the world's supply of molybdenum and, except during the War, these countries have been practically the only producers. During the war period several European and Asiatic countries entered the field ; but in recent years the United States probably has produced 85% of the entire output of the world, and most of the remainder has come from Norway.

Salts in Mill Waters.—In Report of Investigation No. 3149 of the United States Bureau of Mines, A. B. Campbell, W. Howes, and W. H. Ode deal with salts in Tri-State mill waters and their ill-effect on the flotation of blende, and their removal. Summarizing their work,. they say that the use of acid mine waters for milling purposes in the Tri-State zinc district of Missouri, Kansas, and Oklahoma has resulted in corrosion of mill equipment and difficulties in the flotation operations.

The Mississippi Experiment Station of the United States Bureau of Mines in co-operation with the Missouri School of Mines and Metallurgy, Rolla, Mo., has conducted investigations in the laboratory and in the field to combat these difficulties. The investigations showed that :—

(1) The acid waters were most abundant in the eastern part of the Picher district, where carbonates were absent in the ore-bodies. If carbonates, chiefly calcite, were found in the tailing piles the waters did not contain enough acid or metallic salts to cause trouble.

(2) Analyses of the troublesome waters sometimes showed more than 5,000 p.p.m. of free acid and of dissolved salts in the form of sulphates. Ferrous, ferric, and zinc salts and free acids required the most attention because they were found to be the most harmful constituents.

(3) The principal corrosive agents are free acid and ferric sulphate.

(4) The principal flotation toxin is ferrous sulphate ; zinc sulphate requires minor consideration. Appreciable quantities of the sulphates of calcium were found to cause little or no trouble.

(5) The most effective way of removing the harmful constituents is to treat the waters with alkali before they enter the mill, but the reagent cost is prohibitive. By this method the harmless salts of calcium and magnesium would unnecessarily be removed.

(6) The most satisfactory treatment would be selective removal of the ferrous and ferric iron and free acid by alternate periods of aeration and neutralization. This method favours the oxidation of ferrous iron and the removal of the resultant ferric iron in free acid selectively by controlled neutralization. Neutralization may be accomplished most cheaply by upward percolation through high grade limestone : low grade limestones are ineffective. Bases, such as lime and caustic soda act more quickly, but their cost is higher.

Mount Hope, New Jersey.—Recent mining practice and costs at the Mt. Hope mine in northern New Jersey are discussed in detail in Information Circular 6601 of the United States Bureau of Mines, by J. R. Sweet. After a brief preliminary discussion of the history and geology of the district, the author describes in detail the ore-bodies (which are long, narrow lenses of magnetite, plunging at a flat angle, and enclosed in gneissic rocks), methods of prospecting and exploration, surveying and interpreting diamond drill holes, and methods of development and mining. Shrinkage stoping is employed, and a novel feature of the operation is the drilling of 14-ft. holes by means of jackhammer-type drills fitted with stoper legs and operated along a horizontal plank mounted against the stope face by means of ladders. Marked improvements in safety and tonnage broken per man drilling have attended the substitution of this method for the former one of drilling 6-ft. upper holes into the back with stopers. Adequate discussion of stoping practice is followed by sections on underground haulage, hoisting, labour considerations, pumping and ventilation, safety methods, administration, power, and detailed tabulations of costs in units of labour, power and supplies per ton mined, as well as in direct dollar costs.

During the year 1930, 176,474 long tons were hoisted at a total underground cost of $1·31 per ton, which represents a labour cost of 1·129 man hours per ton underground.

Drift Mining.—The methods and costs of drift mining at the property of the Vallecito Mining Co., Angels Camp, California, are described by D. Steffa in Information Circular 6612, of the United States Bureau of Mines. The Vallecito Western mine is a placer gold deposit in the ancient stream bed known as the Tertiary Calaveras. Churn drilling, followed by underground development from a 150-ft. shaft, proved the existence of economically mineable gravels in the channel bottom, and outlined the shape of the "pay areas". The extraction of a portion of one of these areas has provided a check on the thickness, grade, and working characteristics of the gravels, and given a basis for cost estimates. The gravel from development work and from breasting has been treated in a plant near the shaft collar. The recovery process consists essentially of disintegrating and washing the fines in a trommel, discarding the oversize, and passing the fines through riffled sluices to recover the gold. On the basis of the retreatment of 200 tons of mill tailings it is estimated that the mill recovery is nearly 98%. The combined mining and milling cost of the 9,500 tons of gravel taken from the trial area mentioned above was $3·10 per ton.

Concentrating Scheelite Ore.—The concentration of low-grade tungsten ore as carried on at the Silver Dike mill of the Nevada-Massachusetts Co., Inc., near Mina, Nevada, is described by William O. Vanderburg in Information Circular 6604 of the United States Bureau of Mines. The mill has capacity to treat 45 tons of ore per day by tables, but operations at full capacity are handicapped by insufficient space for economical disposal of tailings and a scant water supply. The ore occurs in quartz veins and is mined by a system of shrinkage stopes. The scheelite crystals are relatively coarse and the ore is fairly free of deleterious elements that effect the marketing of tungsten concentrates. However, pyrite and to a lesser extent manganese sulphide are present. The ore is crushed to $\frac{3}{4}$ in. size by two crushers operating in series ; it is reduced further to 12 mesh by two sets of rolls arranged in series. The primary rolls operate in closed circuit with a trommel having $\frac{7}{16}$ in. holes and the secondary rolls with a 12 mesh screen. The crushed product is sized by a 22-mesh screen ; oversize and undersize products are concentrated by tables. The table concentrates are cleaned further by roasting followed by a magnetic separation of the iron sulphide.

For a two-month period of 1931 the mill treated an average of 24·2 tons of ore per day which contained 0·8% of tungsten trioxide. It produced concentrates containing 73·4% of tungsten trioxide, 0·17% of sulphur, and 0·003% of copper. The recovery of tungsten was approximately 81% and the concentration ratio amounted to 114 tons into 1. The milling cost during this period was $2·65 per ton of ore milled. Experimental work on Silver Dike ore indicates that the scheelite can be recovered successfully by flotation methods.

Milling Molybdenite Ore.—The milling of molybdenite ore as practised at the Questa concentrator of the Molybdenum Corporation of America, New Mexico, is described by J. B. Carman, in Information Circular 6551 of the United States Bureau of Mines. The ore contains from 4·5 to 7·5% of molybdenum sulphide and is milled at the rate of 40 tons per day by flotation methods. It is crushed to $1\frac{1}{2}$ in. size by a breaker and then ground in a No. 54 ball-mill which operates in closed circuit

with a 3 by 18 ft. classifier. The classifier overflow containing less than 1% plus 100 mesh and approximately 70% minus 200 mesh material is treated in a rougher cell. The rougher concentrates are cleaned in two stages by cells. The rougher cell tailings after additional treatment in scavenger cells are sent to waste. All middling froths are returned to the head of the flotation circuits. Flotation reagents used comprise pine oil and sodium cyanide ; the latter is used to depress pyrite. The finished concentrate pulp is thickened and further dewatered by a filter. The filter cake, after drying, is sacked for shipment.

During the period February 1 to November 30, 1930, the concentrates produced contained 71·13% of molybdenum sulphide ; the concentration ratio amounted to 16·7 tons into 1 ; and the recovery of molybdenum sulphide was 86·8%. The total operating expense over this period amounted to $2·69 per ton of ore milled.

SHORT NOTICES

Shrinkage Mining.—In the *Engineering and Mining Journal* for June, M. J. Elsing deals with the cost of shrinkage mining.

Mine Cages.—L. Eaton discusses the design of mine cages in the *Engineering and Mining Journal* for June.

Iron-Ore Mining.—Technical advances on the Mesabi Iron Range are discussed by R. H. Bennett in *Mining and Metallurgy* for June.

Rockbursts.—The effect of crush burst movements on stope remnants and workings in their vicinity is discussed by C. J. Gray in the *Journal* of Chemical, Metallurgical and Mining Society of South Africa for April.

Natural Gas Fuel.—L. V. Bender describes the use of natural gas as a fuel at Anaconda in *Mining and Metallurgy* for June.

Coal-Cutting Machines.—Some elements of design of coal-cutting machines contributing to better performance are described by A. F. Cagney in the *Canadian Mining and Metallurgical Bulletin* for June.

Amalgamation and Cyanidation.—C. O. Stee describes the use of a simple arrangement tried at the Siscoe Gold Mines, Quebec, for treatment of the ore by amalgamation and cyanidation in *Engineering and Mining Journal* for June.

Flotation.—Bubble attachment in flotation processes is discussed by O. C. Shepard in *Mining and Metallurgy* for June.

Starch in Flotation.—The use of soluble starch as a depressant for certain minerals while floating gold ores is described by D. N. Vedensky and L. H. Duschak in *Engineering and Mining Journal* for June.

Coal Preparation.—Present-day tendencies in the design of coal treatment plants are examined by H. B. Cooley in the *Canadian Mining and Metallurgical Bulletin* for June.

Refinery Electrification.—A. D. Ross describes the electrification of the Montreal copper refinery in the *Canadian Mining Journal* for June.

Smelting at Ronnskar.—The Boliden Smelter at Ronnskar, Sweden, is described by A. G. P. Paten in *Engineering and Mining Journal* for June.

Mufulira.—Anton Gray describes the geological setting of the Mufulira copper deposit in Northern Rhodesia in *Economic Geology* for June–July.

Pecos Zinc-Lead.—The geology of the zinc-lead deposits at Pecos, New Mexico, is described by P. Kreiger in *Economic Geology* for June–July.

Gold Mining in Novia Scotia.—E. S. R. Smith discusses the causes of unprofitable operation of Novia Scotian gold deposits and the remedy in the *Canadian Mining and Metallurgy Bulletin* for June.

Mayumba, Bas-Congo.—In the *Bulletin Suisse de Min. et Pétr.*, Vol. XII, 1932, A. Amstutz describes the geological structure of the Mayumba region, Lower French Congo.

Northern Rhodesia.—G. V. Douglas discusses mineralization in Northern Rhodesia in *Economic Geology* for June–July.

Classification of Mineral Deposits.—L. Duparc and A. Amstutz discuss the classification of mineral deposits in the *Bulletin Suisse de Min. et Pétr.*, Vol. XII, 1932.

Electrical Prospecting.—The use of the self potential method of ore exploration, illustrated by two surveys in Canada, is discussed by J. J. Breusse in *Engineering and Mining Journal* for June.

Petroleum Geology.—Modern methods in petroleum geology are described by F. G. Tickell in *Mining and Metallurgy* for June.

Petroleum Pipe-Lines.—C. P. Bowie discusses the transport of light oils by pipe-line in Technical Paper 517 of the United States Bureau of Mines.

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.*

34,838 of 1930 (372,829). H. B. Sheppard, Derby. A flexible water container is used as a hydraulic cartridge for breaking down ore.

35,835 of 1930 (372,326). J. W. Flannery, Portland, Oregon. A process for the refining of metals in which a layer of refining material of lower melting point than the metal concerned is introduced into the bottom of the furnace.

36,926 of 1930 (372,759). F. S. Sinnatt, Westminster, and L. Slater, Sheffield. Materials of different specific gravities are separated by alternate suction and pressure of a gaseous fluid in a special separating column.

2,788 of 1931 (372,331). H. Dehottay, Malmedy, Belgium. Solid CO_2 is used for the freezing of soil.

3,830 of 1931 (372,771). Nichols Copper Co., New York. Zinc sulphide ores are treated by a hot mixture of SO_2 and an oxidizing gas, whereby all objectionable sulphur is eliminated from the ore without the need of extraneous heating.

4,326 of 1931 (372,781). J. S. Dunn and Imperial Chemical Industries, Ltd., London. Sulphur in vapour form is treated by alkali-metal sulphides for the removal of arsenic.

15,015 of 1931 (372,958). Falconbridge Nikkelverk, Norway. Nickel-copper solutions containing iron are netralized by adding a metallic nickel product obtained by the gas-reduction of nickel compounds at low temperatures and the iron is removed by hydrolysis on blowing air through the neutralized solutions.

16,112 of 1931 (372,964). A. H. Pehrson, Sweden. The even distribution of heat in electric furnaces is ensured by the use of electrodes short-circuited so as to form resistors, the electrodes being capable of adjustment as to position in the furnace.

20,409 of 1931 (373,003). American Metal Co., New York. Copper wire-bars are cast in water-cooled moulds.

21,937 of 1931 (371,719). Aluminium-Industrie A.-G., Neuhausen, Switzerland. Liquid aluminium is removed from the electric furnace by a device such as a rotating screw, which removes the metal in a continuous stream.

27,714 of 1931 (371,394). J. Smith, Glasgow. Mineral oils are purified by subjecting a mixture of oil vapour and steam to the action of cyanized coke in a special tower or container.

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.

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

Prospecting for Gold. 3rd edition. By Ion L. Idriess. Cloth, octavo, 272 pages, illustrated. Price 5s. Sydney: Angus and Robertson.

Textbook of Geology. Part I—Physical Geology. By C. R. Longwell, A. Knopf, and R. F. Flint. Cloth, octavo, 514 pages, illustrated. Price 23s. London: Chapman and Hall.

Australia. A New Geological Map of the Commonwealth, with Explanatory Notes by Sir T. W. Edgeworth David. Scale 1 : 2,990,000. Price, unmounted, 20s.; mounted, 42s. London: Edward Arnold.

Genesis of the Diamond. By Alpheus F. Williams. 2 volumes, cloth, octavo, 636 pages, illustrated. Price 84s. London: Ernest Benn.

Heat-Treatment and Annealing of Aluminium and its Alloys. By N. F. Budgen. Cloth, octavo, 341 pages, illustrated. Price 25s. London: Chapman and Hall.

Tin Solders: A Modern Study of the Properties of Tin Solders and Soldered Joints. By S. J. Nightingale. Cloth, octavo, 89 pages, illustrated. Price 5s. London: British Non-Ferrous Metals Research Association.

Tyne Main Coal: A Scientific Survey. Summary of Fuel Research Physical and Chemical Survey of the National Coal Resources No. 22. Northumberland and Area: The Main Seam. Paper boards, illustrated. Price 1s. 6d. London: H.M. Stationery Office.

Abandoned Mines: Supplement to Vols. I, II, III, IV, and V of the Catalogue of Abandoned Mines. Paper covers, 60 pages. Price 1s. London: H.M. Stationery Office.

Mining Examinations: Papers set at the Examinations for Certificates of Competency and Surveyor's Certificates, May, 1932. Price 1s. 6d. London: H.M. Stationery Office.

Clay and Shale: The Clay and Shale Resources of Turner Valley and Nearby Districts. By W. G. Worcester. Paper covers, 126 pages, illustrated. Price 20 cents. Ottawa: Department of Mines.

Gold Coast: The Geology of the Obuasi Goldfield. By N. R. Junner. Gold Coast Geological Survey Memoir No. 2. Folio size, 43 pages, with 22 plates and coloured geological map. Price 5s. London: Crown Agents for the Colonies.

Nitrate Deposits of the United States. By G. R. Mansfield and L. Boardman. United States Geological Survey Bulletin 838. Paper covers, 107 pages, illustrated, with map. Price 40 cents. Washington: Superintendent of Documents.

Potash in New Mexico: Mineralogy of Drill Cores from the Potash Field of New Mexico and Texas. By W. T. Schaller and E. P. Henderson. United States Geological Survey Bulletin 833. Paper covers, 124 pages, illustrated. Price 60 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1930. Part I, pp. 431–477, Zinc, by E. W. Pehrson. Part II, pp. 599–773, Coal, by F. G. Tryon, L. Mann, and H. O. Rogers. Washington: Superintendent of Documents.

Metal Statistics: Year Book of the American Bureau of Metal Statistics, 1931. Paper covers, 112 pages. Price $2. New York: American Bureau of Metal Statistics.

Idaho: Report on the Mining Industry of Idaho, 1931. By S. Campbell. Paper covers, 298 pages, illustrated. Boise, Idaho: Mines Department.

F.M.S.: Year Book of the Federated Malay States, 1931. Paper boards, 279 pages, with plates. Ipoh, F.M.S.: Chamber of Mines.

Africa, West, East, and Central: The Manufacturing Industries of the British Empire Overseas, Part VI. By H. N. Carvalho. Folio size, 36 pages, with numerous plates. Price 7s. 6d. London: Erlangers, Ltd.

South Wales: The South Wales Coal Annual, 1932. Cloth, octavo, 299 pages. Price 7s. 6d. Cardiff: The Business Statistics Company.

COMPANY REPORTS

Transvaal Gold Mining Estates.—Formed in 1895 this company works gold mining properties in the Lydenburg district of the Transvaal. The report to March 31 last shows that 197,100 tons of ore was crushed, of which 154,300 tons came from the Central Mines, the gold yield totalling 61,385 oz., equivalent to 6·229 dwt. per ton. The revenue totalled £260,710, while working costs were £227,078, leaving a working profit of £33,632, sundry other profits increasing the total to £42,836. A dividend distributed during the year absorbed £14,299, equal to 2½%. The ore reserve at the end of the year was estimated to be 386,000 tons, averaging 7·9 dwt. in value, representing an increase of 16,450, tons in quantity and a decrease of 0·1 dwt. in value, when compared with the previous year.

Kagera (Uganda) Tinfields.—This company was formed in 1926 and works the Mwira Sandu tin mine in Uganda. The report for 1931 shows that 186 tons of tin concentrates was produced during the year, of which only 142¾ tons was actually sold, the balance of 43¾ tons being reckoned as metallic tin at £110 per ton. Allowing for this the total revenue was £14,308, equivalent to an average price of £76 18s. 7d. per ton. The year's working showed a loss of £6,209, which, added to the debit balance of £6,043 brought in, gave a total debit of £12,252 to be carried forward. The ore reserves at the end of the year were estimated to amount to 1,572 tons of tin oxide, of which 466 tons represented mine ore. This last amount shows an increase of 100 tons over the figure for the previous year, after allowing for 141 tons extracted during the year.

Bisichi Tin.—This company was formed in 1910 and works alluvial tin property in Northern Nigeria. The report for 1931 shows the production for the year to have been 469 tons, equal to 50·48% of the admitted production for 1929, restriction having come into force during the year under review. The quota allowed the company is too small to allow of the working of the steam shovels and accessory plant. The average price realized for the output was £86 15s. 10d. per ton, costs having fallen to £49 16s. per ton at railhead. The profit for the year, after allowing for a proportion of the loss suffered by Treskillard Minerals, Ltd., was £1,771, increasing the credit available to £6,832, which was carried forward. The company's proved reserves in Nigeria are estimated to be 9,333 tons of concentrates in ground averaging 2·1 lb. per cu. yd.

Naraguta Extended Areas.—This company was formed in 1929 and works an alluvial tin property in the Bauchi province, Nigeria. The report for 1931 shows that under restriction the output of tin concentrates was only 117½ tons, as compared with 183 tons for 1930. The average price realized was £74 16s. 2d. per ton, against £88 9s. 9d. The profit for the year was £771, which, added to the sum of £2,556 brought in, gave an available total of £3,327, which was carried forward. The reserves at the end of the year were estimated to be 2,400 tons of concentrates, as at the end of the previous year.

South Bukeru Areas.—This company, formed in 1929, works an alluvial tin property in Northern Nigeria. The report for 1931 shows that owing to restriction only 87 tons of concentrates was produced during the year, against 178 tons in the preceding period of 16 months. The average price realized for tin sold was £69 9s. 3d. per ton, against £87 6s. 11d. The accounts show a profit of £666, which, added to the balance of £359 brought in, gave an available total of £1,025, of which £619 has been written off the holding in Naraguta Durumi Areas, Ltd., and the balance £406 transferred to reserve. The reserves at the end of the year were estimated to be 708 tons of tin concentrates, against 700 tons at the end of 1930.

Zinc Corporation.—Formed in 1911, this company works lead-zinc properties in the Broken Hill district, New South Wales. The report for 1931 shows that 264,979 tons of ore was raised, against 337,041 tons in the previous year, the mine only working 75% of normal full time. The mill treated 265,740 tons of ore, producing 53,098 tons of lead concentrates, averaging 72·9% lead and 17·3 oz. silver per ton, and 40,377 tons of zinc concentrates, averaging 52·8% zinc. Working costs were further reduced during the year to £26 5s. in Australian currency. The quantity of lead realized during the period was 45,454 tons, against 34,388 tons in 1930, the average price realized being £13, against £18. The mine accounts show a working profit of £52,520, against a loss of £41,874 in 1930. Interest and other revenue totalled £78,199, against £113,787. The amount available, after adding the balance of £26,585 brought in and making various allowances, was £177,972, of which dividends absorbed £71,609, appropriations for plant and development £70,000, leaving a balance of £36,363 to be carried forward. The ore reserves at the end of the year were estimated to be 2,800,000 tons on the lead lode and 249,000 on the zinc lode, the reduction in the total reserves being only 80,000 tons, in spite of the fact that development was at a standstill.

Indian Copper.—This company was formed in 1924 and works copper properties in the Singhbum district of Bengal, India, with a smelter near the railway. The report for 1931 shows that 163,124 wet short tons of ore was sent to the mill, against 135,615 tons in 1930, the grade rising from 2·87% to 3·17%. The mill treated 161,563 tons, producing 17,964 tons of concentrates. The output of the refinery was 4,069 long tons of refined copper, against 2,974 tons in 1930, while the rolling mill turned out 3,637 long tons of yellow metal sheet. The year's working resulted in a profit of £51,184, which with the £6,401 brought in, gave an available total of £57,585. Of this amount £6,479 was written off mine development expenditure, £4,110 off promotion expenses, £20,000 transferred to reserve, debenture interest £20,985, the balance of £6,011 being carried forward. The ore reserves at the end of the year were estimated to be 691,942 short tons, containing 3·25% copper. A favourable report on the property was received from Mr. C. O. Lindberg during the year.

Tronoh Mines.—This company was formed in 1901 and works alluvial tin properties in the Kinta district, F.M.S. The report for the year 1931 shows that the output of tin ore from the company's dredges was 870 tons, although 1,488 tons of ore was sold, against 1,447 tons in 1930. Sales of ore realized an average of £72 12s. 2d. per ton, against £91 16s. 1d. per ton in the previous year. The profit for the year was £30,293, which, added to the balance brought in, gave an available total of £86,526. Dividends paid during the year, equal to 5%, absorbed £15,000, while £21,920 has been allowed for depreciation, leaving a balance of £49,606, which was carried forward.

Southern Tronoh.—This company was formed in 1927 and works alluvial tin property at Tanjong Tualong, Perak, F.M.S. The report for the year 1931 shows that under restricted operation the output of tin ore was 441 tons, sales of ore realizing an average of £71 6s. 8d. per ton, against £90 0s. 8d. in 1930. The profit for the year was £2,838, increasing the balance available to £3,012, which was carried forward.

Sungei Besi.—This company was formed in 1909 and operates alluvial tin areas in the Kuala Lumpur district, F.M.S. The report for the year 1931 shows the output of tin ore for the year to have been 482¾ tons, against 499 tons for the preceding year. Sales of ore realized £71 9s. 4d. per ton, against £99 19s. 2d. in 1930. The profit for the year was £7,561, which, added to the credit balance brought in, gave an available total of £39,613. Of this amount £17,588 has been allowed for depreciation, leaving a balance of £22,025 to be carried forward.

Lahat Mines.—This company was formed in 1906 and works alluvial tin property in the F.M.S. The report for 1931 shows the output of tin ore to have been 205 tons, as compared with 170 tons in the previous year. The amount realized was £15,467, equal to £75 8s. 1d. per ton, against £89 8s. 6d., obtained in the previous year. The accounts show a deficit for the year of £499, reducing the credit balance brought in to £3,516. At the end of February last the mine was let to a tributor, the low price of tin and restriction obligations compelling the company to cease work on its own account.

Talerng Tin.—Formed in 1927 this company works alluvial tin property in Southern Siam. The report to October 31 last shows that the dredge

installed could not be made to work properly and, finally, operations were closed down. The property account, at £164,692, includes the cost of the new 160-acre block, on which liability was completely discharged by the issue of 25,000 fully-paid shares. The loan was increased by £21,100 during the year, while the development account was increased by £25,290 to £66,326.

Siamese Tin.—This company was formed in 1906 and works alluvial tin properties in the Renong district. The report for 1931 shows that on the Ngow estate 1,416 tons of tin ore was recovered, which realized $946,605, the working profit being $348,562. At Takuapa, 610 tons of tin ore was produced, the working profit here being $75,074. The company's mines are now working on an approximate ⅔ basis, owing to the imposition of restriction measures. The accounts show that, after writing off £4,015 from prospecting expenditure and providing for amortization and depreciation, there remained a net profit of £7,171, increasing the credit balance brought into £11,908, which was carried forward.

Bangrin Tin.—This company was formed in 1920 to acquire alluvial tin properties in the Renong district of Siam from the Siamese Tin Syndicate, Ltd. The report for 1931 shows that 3,500,500 cu. yd. of ground was treated for a recovery of 948 long tons of tin concentrates, which realized $655,357, the gross working profit being $222,792. The accounts for the year show that after making various allowances the net profit was £11,378, increasing the credit balance brought in to £42,786. Of this amount, £22,888 has been written off the three dredges, leaving a balance of £19,898 to be carried forward.

Oriental Consolidated.—This company was formed in 1897 in America to work a gold mining property in the Chosen district, North-Western Korea. The report for 1931 shows that 195,488 tons of ore was mined and sent to the mill, the total yield being estimated at $1,124,459, the cost of mining being $421,699 and the net profit $161,377. The ore reserves at the end of the year were estimated to be 285,000 tons, having a gross value of $1,535,000, a decrease of 35,000 tons in quantity and $165,000 in value, when compared with the figures at the end of 1930.

Esperanza Copper and Sulphur.—This company was formed in 1906 and it holds the entire share capital of the Seville Sulphur and Copper Company, working mines near Seville, Spain, besides having a controlling interest in the Cyprus Sulphur and Copper Company. The report for 1931 shows that the Aznacollar mine of the Seville company worked intermittently during the year, work being entirely suspended for two months. The Lymni mine of the Cyprus company worked steadily throughout the year. The profit for the year was £7,075, which added to the credit balance brought in, gave an available total of £26,820, which was carried forward. It is noted that the losses of subsidiary companies have not been taken into account in arriving at these figures.

Geevor Tin.—Formed in 1911 this company works lode-tin properties at Pendeen, St. Just, Cornwall. The report for the year ended March 31 last shows that owing to the low price of tin, operations were confined mainly to maintenance work until January 28 of the present year, when mining operations were resumed on a restricted scale. Prior to the recommencement of milling, the treatment of yard tailings had yielded 22½ tons of concentrates, which realized £1,169. From January 28 to the end of the year under review, 5,736 tons of ore, of which 5,700 tons came from the Victory Shaft section, yielded 91 tons of black tin, which realized £5.486. The profit and loss account shows a loss of £10,732, which was carried forward.

South Crofty.—This company, formed in 1906, works a lode-tin property at Illogan, Cornwall. The report for 1931 shows that until October 12, 1931, the operations were confined mainly to pumping, crushing being resumed on that date. Up to the end of the year, 9,306 tons of ore was treated, 113⅛ tons of black tin being recovered, worth £10,264, in addition to 71¼ tons of arsenic, worth £2,480. No new development has been undertaken since restarting the mill. The loss of the company for the year under review was £15,564, but it is now stated that the present sales of tin and arsenic cover most of the outgoing. The company continues to hold a stock of wolfram.

British-Borneo Petroleum.—This company was formed in 1912 and has oil interests in various parts of the world. The report for the year to March 31 last shows that a new interest has been acquired in Germany, where drilling operations will shortly commence. The net profit for the year was £11,010, against £12,370 in the previous year, a dividend of 5% being declared. The balance carried forward was £11,825, after placing £25,000 to capital expenditure.

DIVIDENDS DECLARED

Apex.—6d., less tax, payable August 16.
Ayer Hitam.—1½d., less tax, payable June 30.
Broken Hill South.—1s., less tax, payable August 12.
Cam and Motor.—10s. (including 7s. 6d. return of capital), less tax.
Gopeng.—3d., less tax, payable July 7.
Henderson's Transvaal Estates.—5%, less tax.
Rand Mines.—2s., less tax, payable August 16.
Rezende.—2s. 6d., less tax.
Sherwood Starr.—9d., less tax.
South African Coal Estates.—6d., less tax, payable August 17.
South Kalgurli.—6s. 6d. (including 2s. 6d. return of capital), less tax, payable July 26.
Vereeniging Estates.—4%, less tax, payab'e July 30.

NEW COMPANIES REGISTERED

Applied Geophysics.—Registered as a private company. Capital: £100 in £1 shares. Objects: To promote and carry out geophysical, geological, and other scientific investigations, etc. Directors: A. B. Thompson, J. Romanes, C. Dabell, W. M. G. Young, O. Weiss. Office: 18, St. Swithin's Lane, E.C. 4.

Cumbre Trust.—Registered as a private company. Capital: £30,000 in £1 shares. Objects: To acquire lands, mines, minerals or other property in Chile or elsewhere in South America, etc. Directors: A. W. Bolden, A. A. F. de Wandre, G. Theunis, Lt.-Col. A. C. Macdonald, D.S.O., Capt. Sir David Wilson Barker, W. J. Welch, and W. S. Eyre. Office: 110, Cannon Street, E.C. 4.