The Mining Magazine

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CONTENTS

EDITORIAL

IN this issue a summary of operations in connexion with the petroleum industry is given, which will doubtless prove of interest. Further information on this subject will be published from time to time as and when it becomes available.

WE have had occasion to comment before on the work which Sir Harold Carpenter is doing in his researches into the interior structure of metals and in particular into the properties of single crystals. It is therefore of interest to place on record that he has lately contributed further to our knowledge of the subject in a paper before the Royal Institution delivered on May 30. This is in the nature of a review of all the work done by various investigators to date.

ANOTHER congress is forthcoming, this time at Stockholm, where from August 15 to 23 will be assembled the fourth general meeting of the International Union for Geodesy and Geophysics. Papers will be read on all aspects of these subjects, including oceanography, meteorology, and volcanology. An exhibition of geophysical instruments and practical survey results is to be held in connexion with the meeting and a number of excursions are planned to places in Sweden where finds have been made by these methods.

THE Government has published during the past month the conclusions which have been reached with regard to closer union in East Africa. Except for some possible indirect effects these have little to do with the mining industry, so that there is no necessity to quote from the White Papers. It is of interest, however, to record that the proposals meet with considerable opposition on account of their insistence on the paramouncy of the native interests, which is felt to be tantamount to regarding the white settler as an intruder.

THE British South Africa Company, together with the Rhodesian Anglo-American and the Bwana M'Kubwa Copper Mining Company, have recently awarded two scholarships at the Royal School of Mines for graduates in mining of that School to take a further year in mining geology. The two selected students have already started for a vacation tour of the mining fields situated in the Pre-Cambrian region of Canada, from which tour they will return to begin the next session in October. In addition, the two companies mentioned, with the Rhodesian Congo Border Concession, have made arrangements for seven scholarships of £100 a year each of four years' duration to assist boys from selected public schools to take the four years' course at the Royal School of Mines beginning in October, 1930.

The Royal School of Mines Dinner

The 53rd Annual Dinner of the Royal School of Mines, under the auspices of the Old Students' Association, was just such a happy family gathering as usual and many familiar faces were seen. Those who were at this function exactly a year before will probably remember that one of the salient features of the speeches was the existing shortage of men of the right type for mining engineering. This was also the major topic at this year's dinner. Dr. William Cullen, who proposed the toast of the School for the second year in succession (is this a record?), raised the subject by referring to a letter recently published in the *Times* by the Professor of Mining at Birmingham University—a letter which has occasioned, rightly or wrongly, a good deal of irritation. Dr. Cullen is of opinion that one of the most powerful deterrents to embarking on the profession of mining engineering is the fear of phthisis. This is probably true of South Africa, while the fact that the medical restrictions are severe probably prevents many parents in the home country from starting their sons on an expensive course of training which may only culminate in their being rejected as unfit for duty, not only on the Rand but elsewhere. It has to be borne in mind, too, that prior to the beginning of the present intensive development in Northern Rhodesia the mining industry of the Empire was in a very depressed condition and there was therefore little inducement for men to enter it. This apparent want of enterprise in young men may also be due to the increased attractiveness of commercial life at home, as discussed here anent this dinner a year ago.

From examining the malady Dr. Cullen went on to consider a cure and was disposed to make a comparison between the University of the Witwatersrand and the mining training institutions in this country. In the former there was until recently a big

falling off in students, as in the latter, but as a result of some change in the curriculum, resulting in the devotion of more fourth-year time to practical experience with pay—as recorded by our Johannesburg correspondent in this issue—the numbers have been increasing considerably. It was not necessary for a protagonist of the Royal School of Mines to contest this proposal, any more than it is now necessary for the MAGAZINE to do so, because a later speaker at the dinner—Mr. W. E. Wainwright, the president of the Australasian Institute of Mining and Metallurgy—uttered a spirited plea for "leaving the fourth year alone." We endorse his opinion for the reason that the courses in mining and metallurgy being wide in their scope do not admit of any contraction. There is, too, plenty of time in the vacations for obtaining practical training if only the facilities were available. It is not altogether reasonable to make analogies between this country and America, Canada, and South Africa, because the cardinal fact remains that in Great Britain there are no metal mines and metallurgical works comparable with those in the other countries named. Mr. E. Halse replied to the toast and, as his memory goes back to the period 1873–6, when he was a student, he was able to indulge in some interesting reminiscences. Other speakers were Major Henderson-Scott, who proposed the guests, and Mr. Charles McDermid, who replied, whilst Mr. E. T. McCarthy proposed the chairman, who was a contemporary with him at the School.

There is one other point dealt with by the principal speaker which merits special attention. He made a plea for some form of conference between the leaders in the industry and educationists. Many critics may be disposed to express the opinion that conferences "get you nowhere." Be that as it may, there is no gainsaying the fact that some closer liaison between the technical and other leaders in the industry and, say, the Royal School of Mines would be advantageous to both. This brings us again to the all-important question of how to supplement the practical training at present available to students in this country. Here the industry can definitely help by affording opportunities to young men in their second and third years of working on properties which, although near home, may be beyond the means of the average student to reach in his vacation time. Additional facilities for post-graduate work in mines further afield should also become available. This is a duty which the industry owes to such institutions as the Royal School of Mines. It may be said that such facilities do exist, but is there not some necessity to increase them? The selection of men for such "scholarships" or "travelling fellowships" should also be on all-round merit rather than solely on academic attainments, following the oft-quoted reasoning that the best student does not necessarily make the best engineer. Mr. Wainwright carried this suggestion a stage further by reminding us of the system in vogue in Australia whereby certain big mining companies secure young men before graduation and initiate them on the properties during vacation time, subsequently giving them employment.

Three European Gatherings

The Continent witnessed two important conferences last month each of which attracted the attention of mining men, while a third, of interest to the geological community, has just concluded. The Second World Power Conference, held in Berlin from June 15 to 25, was attended by delegates from no fewer that 55 countries, among whom were several prominent in mining. It will be recalled that the first conference was held at Wembley in 1921, while sectional meetings have in the interim been held at Bâle, London, Barcelona, and Tokio. It is beyond the province of the MAGAZINE to enter into details concerning this conference, but one circumstance regarding it deserves to be placed on record. Naturally most of the papers and the discussions thereon were in the German language, but delegates of other countries not familiar with this tongue experienced no difficulty in following the proceedings by reason of the elaborate interpreting arrangements available for translating into either French or English. In each of the three halls in which sessions were held the speaker's rostrum was fitted with a microphone connected to head telephone sets at the interpreters' table. The interpreters in turn were able to transmit by means of other microphones in one of the three languages, each seat in the auditorium being equipped with headphones and change-over and volume-control switches. Except for a slight time lag in the case of those transmitters who had to translate from the speaker's language, the system worked well on the whole.

The second conference in chronological order was the Sixth International Congress of Mining, Metallurgy, and Applied Geology, held at Liége from June 22 to 28, which, as it is of more direct interest to readers, may be dealt with more fully. In this case the previous meeting was held at Dusseldorf in 1910 and the next should have been held in 1915, but hostilities, of course, prevented it. Advantage was, therefore, taken of the Belgian national celebrations on the occasion of the centenary of that country's independence to hold the present session there and in connexion with the Liége and Antwerp Exhibitions. During the period mentioned the mornings were for the most part given up to technical sessions, the afternoons to visits to mines, works, or places of geological interest, and the evenings to entertainments, which the hosts were most lavish in providing. Congratulations for the organization are especially due to Professor Fourmarier, of the University of Liége, for his able presidency, and to Mr. O. Lepersonne for his equally creditable secretary-generalship. Papers in the mining section dealt with all aspects of the subject in both coal and metal mining, while the metallurgy section covered both the ferrous and non-ferrous. In geology was included a geophysics section. All these sessions were particularly well attended by delegates from the countries represented and although the language difficulty was a barrier it was not an insurmountable one. Among the places visited particular mention may be made of the manganese mines of the Vallée de la Lienne, the limestone galleries at Néblon, the works of the Vieille Montagne at both Calamine and Baelen, and the electrolytic copper refinery of the Union Minière at Oolen.

The third conference referred to was the centenary celebration of the French Geological Society, held in Paris, which was also attended by delegates from many countries. This again was an occasion for technical sessions, many excursions over a wide field, and social entertainments, to which a number of people passed on from Liége. It is proposed to give a brief description of the exhibitions at Antwerp and Liége in the next issue of the MAGAZINE, but it might be added here that a formal decision was made at the closing session in Liége to hold the next International Congress in France in 1935, invitation having been formally extended on behalf of the interests concerned.

The Institution's Annual Meeting

Particular interest attached to this year's meeting of the Institution, because the report of the Council for the year just concluded contains the first official detailed information concerning the new housing proposals for members. There was, however, another reason for special interest in this meeting, that Sir Thomas Holland was to be presented with the Gold Medal. This award was deservedly popular, for Sir Thomas has served the Institution well both as president for two successive years and as an active member of the Council for several more, whilst his public services as Director of the Geological Survey of India and as Rector of the Imperial College are well known.

Dr. William Cullen performed one of his last acts as president in moving the adoption of the annual report and referred to the success of the Congress in South Africa, following this by a recapitulation of the arguments in favour of the removal of the headquarters of the Institution from Cleveland House to Westminster, where it will be joint tenants with a number of other societies. In view of the present state of unemployment in the profession, Dr. Cullen also felt it desirable to indicate that the function of the Institution's Appointments (Information) Register must be confined to that of acting as a clearing house and pointed out that the Institution, in virtue of its Charter, is precluded from acting as an employment agency whereby preference might be given to one member over another. The report and accounts having been adopted, the president then presented the Gold Medal to Sir Thomas Holland, suitably referring to his record. Sir Thomas, in accepting the award, spoke of the loyal co-operation of his staffs, both in India and London, subsequently dealing with the reform of the machinery for the collection, control, and study of mineral statistics during his last year of office in India, as a result of which information had been gained as to the policy to be adopted by the Survey to ensure the development of the mineral resources of the country. This also resulted in the Government formulating rules for the granting of mineral concessions which had since been closely followed in principle by other parts of the Empire. Sir Thomas also spoke of the circumstances associated with the granting of the B.Sc. Degree of London University to Associates of the Royal School of Mines, a change for which

he was chiefly responsible. Other awards announced at this meeting were those of the "Consolidated Gold Fields of South Africa, Ltd.," Premium of Forty Guineas to Mr. John B. Richardson, the "William Frecheville" Students Prize of Ten Guineas to Mr. Arthur Bray and the "Arthur S. Dwight" Post-Graduate Travelling Grant of Two Hundred Guineas to Mr. W. D. Jones, the last mentioned being the first such award to be made. A special grant of £50 from the "Post-Graduate Grants Fund" has been made to Mr. S. R. B. Cooke to enable him to proceed from New Zealand to British Columbia to gain practical experience.

The meeting concluded with the delivery of his presidential address by Professor J. G. Lawn, the subject chosen being "Periodical Variations in the Prices of Minerals and Metals." Professor Lawn first deals with the use of metals as money, and reviews the various stages which have led to the present ascendency of gold over silver, passing on to an historical survey of the variations that have taken place in the prices of some of the metals and concluding with a discussion on the effects of control to assist the producer by maintaining a stable and economic price. The paper will undoubtedly be read with as much interest by those who were not present as it was heard by those who listened to it.

The Origin of the Rand Gold

The story of the development of the gold mines of the Transvaal, which yearly contribute more than half of the world's annual output of the precious metal, forms one of the most wonderful chapters in the history of mining. That a district of such importance to the world should have been well studied by geologists of many nationalities is not surprising, but it is thus the more remarkable that, although the discovery of the "banket" was made in 1886, there is even now no unanimity on the question of the origin of the gold it contains.

This question of the origin of the gold has caused much discussion and as far back as 1903 De Launay summarized the various hypotheses and showed that there were three main theories, which are usually known as the placer, the precipitation, and the infiltration theories. These, in the same order, assume the gold to have been deposited before, during, or after the conglomerate itself had been deposited. The placer theory supposes the gold to have been mechanically deposited at the same time as the pebbles, all being derived from the denudation of pre-existing auriferous rocks. The second theory regards the gold and pyrite as being chemically precipitated from the water in which the pebbles were being laid down, while the supporters of the infiltration theory hold the view that the deposits are epigenetic, the gold, together with pyrite, some quartz, and other secondary minerals, having been introduced by ascending magmatic waters, thus regarding the metal as of post-sedimentary origin. The precipitation theory has, perhaps, now been entirely abandoned, in view of the many difficulties which are involved in its support, and Du Toit has pointed out that the many arguments advanced in favour of either of the other two theories can, with but slight modification, be equally well applied to the other, and that there are very strong arguments against both of them. Du Toit regards the criteria to be as yet indecisive to establish the ascendency of any one view and thinks that more evidence on crucial points is desirable.

At a meeting of the Institution, held in November, 1928, Mr. Arthur Bray, in a paper on the banket deposits of the Gold Coast (for which he was awarded the William Frecheville Students Prize of the Institution of Mining and Metallurgy)—deposits which are very similar to those of the Rand—considered that all the evidence was in favour of the deposition of the gold from ascending mineralizing solutions, a view which was, however, disputed by Dr. Junner in 1929, the latter, together with Sir Albert Kitson, holding the placer theory to be the more probable. The whole question, which may, perhaps, be regarded as purely academic, but which has economic importance when the future of the district is considered, has been re-opened by Professor L. C. Graton, of Harvard. Professor Graton, in a paper which is issued as a supplement to *Economic Geology* for May, supports a hydrothermal origin for the Rand gold. The method followed by this writer has been to show that the facts are incompatible with the demands of the holders of the placer theory, while they are compatible with the view that "the gold has been introduced from a deep-seated magmatic source by hydrothermal solutions of the same kind as have produced many of the other great gold deposits of the world." The argument of Professor Graton is certainly very convincing.

REVIEW OF MINING

Introduction.—Perhaps the most important event in the City during the past month has been the passing of a resolution by certain eminent bankers and City merchants advocating urgent measures for the promotion of Inter-Imperial trade. It is felt that the Empire is sufficiently self-contained to form a single economic unit and support is growing for the policy underlying the resolution. The prices of metals still occasion anxiety, the further setback in tin being due to lack of unanimity among producers, whilst another disturbing factor is increased unemployment.

Transvaal.—The output of gold on the Rand during June was 847,352 oz. and in outside districts 40,515 oz., making a total of 887,867 oz., as compared with 916,213 oz. in May. At the end of June the number of natives working in the gold mines was 201,324, as compared with 202,182 at the end of May.

The accompanying table gives the dividends for the first half of 1930 for the gold mines of the Rand and the Heidelberg district. The noteworthy increase is that of Langlaagte Estate and other increases are shown by Durban Roodepoort Deep, Geldenhuis Deep, and Rose Deep. On the other hand there are some drops to be recorded. That of the New Modderfontein was expected sooner or later, perhaps, as it has become necessary to treat a larger portion of lower grade ore from the upper leaders and south reef, and in the case of the Van Ryn Deep the last annual report showed a slightly reduced grade of ore reserves as well as reduced earnings. The less favourable developments at the Brakpan had also foreshadowed reduced profits. Other decreases are shown by Consolidated Main Reef and Modderfontein East.

	2nd half, 1928.	1st half, 1929.	2nd half, 1929.	1st half, 1930.
	s. d.	s. d.	s. d.	s. d.
Brakpan	5 0	4 9	5 0	4 3
Consolidated Main Reef	1 0	1 0	1 0	0 9
Crown Mines (10s.)	3 0	3 3	3 3	3 3
Durban Roodepoort Deep	—	—	—	0 3
Geduld	3 6	3 0†	3 3†	3 3†
Geldenhuis Deep	0 6	0 6	0 6	0 9
Government Areas	2 3	2 3	2 3	2 3
Langlaagte Estate	1 6	1 6	1 6	2 0
Modderfontein B (5s.)	2 0	2 0	2 0	2 0
Modderfontein Deep (5s.)	3 6	3 3	3 6	3 3
Modderfontein East	2 0	2 0	2 0	2 0
Modderfontein, New (10s.)	7 0	7 0	7 0	6 9
New State Areas	1 6	1 6	1 0	1 6
Nourse Mines	0 6	—	0 6	0 6
Robinson Deep (A. 1s.)	1 6	1 6	1 6	1 6
Rose Deep	—	—	—	0 6
Springs Mines	3 6	3 6	3 9	3 6
Sub Nigel (10s.)	3 0	2 0	2 0	2 0
Van Ryn	0 6*	0 6*	0 6*	0 6*
Van Ryn Deep	4 0	3 6	3 6	3 0
Village Deep	0 6	0 6	0 6	‡
West Springs	1 0	1 0	1 0	1 0
Witwatersrand Gold	—	—	0 6	1 0

* Tax free. † On increased capital.
‡ Mine now owned by Robinson Deep.

The dividends of the finance companies are compared below :—

	1st half 1929.	2nd half 1929.	1st half 1930.
	s. d.	s. d.	s. d.
Johannesburg Consolidated	1 6*	1 6*	1 6†
New Era Consolidated	0 3	0 3	—
Rand Mines	2 6	2 6	2 6
Rand Selection	0 9	0 6	—

* Tax free. † Less tax.

In the case of the Rand Selection Corporation it has been announced that the board consider it desirable to husband the resources of the company pending an improvement in business conditions.

At the annual meeting of Henderson's Transvaal Estates, to be held this month, it is proposed to reduce the capital of the company from £1,075,000 to £860,000, and the share value from 5s. to 4s. Holders of the 2,818,487 issued shares will receive 1s. returned capital on each share held. Operations for the year ended March 31 last resulted in a net profit of £39,071, as compared with £36,196 in the previous year. A dividend of 5% was paid in each year.

A fall of rock in the Consolidated Main Reef mine about the middle of June caused the loss of several lives.

At the quarterly meeting of the Johannesburg Chamber of Mines, held last month, Dr. P. M. Anderson said that, as a result of the new Mozambique Convention, the number of East Coast natives employed on the Rand had decreased from 92,000 to 78,000. He reiterated the view that the industry was likely to be faced with a serious shortage of native labour, as the supply within the Union itself was inadequate.

Southern Rhodesia.—The output of gold from Southern Rhodesia during May was 47,645 oz., as compared with 45,806 oz. in April and 48,189 oz. in May of 1929. Other outputs in May were : Silver, 5,802 oz. ; copper, 128 tons ; coal, 90,680 tons ; chrome ore, 22,983 tons ; asbestos, 2,762 tons ; mica, 19 tons ; diamonds, 18 carats.

A circular issued last month to shareholders of the Gaika Gold Mining Company, Ltd., stated that developments at the mine continue to be disappointing. Although every effort has been made to discover fresh ore, the reserves are rapidly being exhausted. It is also revealed that negotiations have been going on for a considerable period to dispose of the mine as a going concern or, failing that, of the plant, but, so far, without success. It is estimated that in the event of liquidation sufficient assets are available to permit of a distribution of at least 4s. per share.

Northern Rhodesia.—The report of the Rhodesia-Katanga Company for the period ended December 31 last, which was issued last month, contains a summary of progress at the Kansanshi mine. Work to date shows that, in addition to the high-grade fissure veins worked in the early stages of development before the War there are large bodies of other copper ores being developed. These are two large replacement deposits in the dolomite on the east and west sides of Kansanshi Hill and sulphide-bearing beds of graphite schist and quartzite forming low-grade copper ore-bodies of considerable thickness. Development is being advanced with the object of arriving at a decision as to the scale on which operations shall be conducted. The treatment plant will be designed by Mr. A. E. Wheeler, who has had extensive experience with the ores of the Katanga. As soon as possible a direct railway connexion will be made with the Belgian section of the Benguela Railway, which will link the mine with the port of Lobito on the Atlantic seaboard.

Shareholders of the Rhodesian Congo Border Concession have been informed of new bore-hole results. Bore-hole N.E. 26, which lies approximately 1,000 ft. east of bore-hole N.E. 7 on the western extension of the N'Changa area, entered the Lower or River lode horizon at 593 ft. and to 647 ft. the ore averaged 6·46% copper, of which 47·2% is in the form of sulphide.

Shareholders of Rhodesian Anglo American, Ltd., have been offered a further 600,000 shares pro rata to their holdings. The new 10s. shares are offered at 30s. per share and will have option rights. A circular issued by the company states that a large portion of the present cash resources will be required to provide the funds necessary to enable certain Northern Rhodesian companies to be brought to the production stage and that the new issue has been made to provide means for the acquisition of further interests in the same field.

Nigeria.—At a meeting of the Nigerian Chamber of Mines, held in London on July 1, the recommendation of the executive committee of the Tin Producers' Association for a two months' shut-down of production was endorsed. It was decided that the companies operating in Nigeria should restrict their production over three months to one third of their average monthly production in 1929.

Australia.—The low prices prevailing for lead, zinc, and silver have had serious effects on the Broken Hill group of mines. Towards the end of June a meeting took place between representatives of the Barrier Industrial Council and the Sulphide Corporation, Broken Hill Proprietary, and Block 14 to consider the suggestion of the operating companies that the unions should assist them during the present slump by agreeing to a reduction of 17½% in wages and in contractor's earnings. This suggestion, as the companies explained, would still mean that they would shoulder more than half the loss, but it was nevertheless rejected by the unions. Broken Hill North have closed the British mine and Block 14 has since been closed. It is stated that the works of the Electrolytic Zinc Company of Australia are not affected by the closing down of these mines, as large stocks of concentrates are still available.

Towards the middle of June the Mount Lyell Mining and Railway Company announced that extensions of the concentrating plant and of the electrolytic refinery, which would enable the output of copper to be increased to 13,000 tons per annum, had been authorized. The mill, as reorganized, would be capable of treating 1,000 tons of ore per day. This tonnage it was estimated would enable a profitable output of copper to be made with ore of a lower grade than hitherto. This announcement was followed by a notice that the company had decided to make an issue of 257,839 new shares at par and to offer these to present shareholders in the proportion of one new share for every five shares held.

Burma.—The Burma Corporation has announced interesting developments on two lodes. The Meingtha ore-body has been cut on No. 2 and No. 6 levels. On the former a cross-cut east at 3,502 ft. south exposed

52¾ ft. of ore assaying 15% lead, 14·1% zinc, 3·9% copper, and 16½ oz. silver per ton, while on No. 6 level a cross-cut west at 2,756 ft. south has exposed 8 ft. true width lead ore assaying 23·4% lead, 13·7% zinc, 0·1% copper, and 18½ oz. silver per ton and, in addition, 4 ft. true width of copper ore assaying 0·2% lead, 4·2% zinc, 6·6% copper, 2·68% nickel, 0·87% cobalt, and 5·9 oz. silver per ton. The Shan lode has been cross-cut on No. 9 and No. 10 levels. On the former a cut east at 689 ft. north exposed 7½ ft. of ore assaying 34·7% lead, 18·1% zinc, 0·2% copper, and 25·9 oz. silver per ton, while on No. 10 level a cross-cut east at 260 ft. north has exposed 12¾ ft. ore assaying 31·2% lead, 14·3% zinc, 0·1% copper, and 27½ oz. silver per ton.

Malaya.—A circular to the shareholders of the Ipoh Tin Dredging, Ltd., was issued with the annual report. The circular states that, in view of the limited area remaining to be worked by No. 1 dredge, approximately 400 acres of tin-bearing ground in the Ulu Langat district, near Ayer Etam, have been acquired. Of the new area it is considered that 85 acres are sufficiently rich to be worked at the present price of tin. In addition a dredge has been purchased from the Ampang (Perak) Tin Dredging Co., Ltd. (in liquidation). This dredge is capable of treating 150,000 cu. yd. per month.

The Talerng Tin Dredging Company in a circular to shareholders announces that the dredge has been successfully tried out, but that it has been decided to suspend active operations for an indefinite period, those responsible holding the view that it would be undesirable to dissipate the exhaustible resources of the company at the present uneconomic price level. The dredge trials have shown that 200,000 cu. yd. per month can be handled, an amount which it is estimated would yield 780 tons of tin oxide annually. Exploration has been continued and the ore reserves of the company have been increased.

Panama.—In the sixteenth progress report of the Panama Corporation further details are given of work on the extension of the Mina Blanca lode at La Cuelga, 5,000 ft. north of the main workings. At the tunnel face the gold content of the lode was 38s. to the ton over 24 in. Development has also been carried out at other points north and south of the main workings. At Cerro Caballo, 40 miles west of Mina Blanca, a tunnel has revealed ore assaying 79s. over 48 in. On the southern portion of the Remance property the mine on Powder House Hill is being prepared for stoping operations. In order to increase the rate of development and at the same time to obtain returns of gold on a commercial scale as soon as possible it has been decided to instal hydraulicking plant immediately to work the deposits on El Mineral in Block 1. This will be the third producing plant now under construction.

Spain.—An interim report issued by the Tigon Mining and Finance Corporation states that the erection and installation of the mining machinery and electric plant on the sulphur mines in Spain belonging to the corporation have been completed. The machinery installed has a capacity more than sufficient to supply the present treatment plant, the first unit of which has also been erected. The corporation has arranged to purchase two well-known sulphur-producing properties in Chile.

Italy.—A circular to shareholders of Rayweavers, Ltd. states that the company has acquired a one-half interest in a company owning asbestos mines in northern Italy. The properties have been examined by Messrs. Bewick, Moreing, and Co. and it is estimated that the visible supplies of ore contain 300,000 tons of asbestos. It is proposed to establish production on a basis of 2,000 tons per annum.

Flintshire.—The Halkyn District United Mines, Ltd., are engaged in extending the old Milwr Tunnel, which starts from sea-level on the River Dee and had been driven 3·37 miles before the present company took the work over. The extension to the middle of June had been driven 7,246 ft. The work has been hampered by inrushes of sand and water, but conditions are improving and during 12 recent weeks the average advance was 149·4 ft., the best week showing an advance of 169 ft., which is probably a record for this country. During this week of 138 hours 27 cuts were shot, averaging 6·26 ft. each, and the best time for a complete cycle of operations was 4 hours. The tunnel is 10 ft. wide by 8 ft. high, with a waterway 4 ft. wide by 2 ft. 6 in. deep in addition, and is being driven in massive limestone with a grade of 1 in 1000. Consumption of explosives is particularly heavy. Two S 70 Ingersoll-Rand drills are used, with a Sullivan slusher for mucking, and haulage is effected by means of a B.E.V. storage battery locomotive.

THE ESTIMATION OF SMALL QUANTITIES OF TIN

By J. E. CLENNELL, B.Sc., A.I.M.M.

PART I.—VOLUMETRIC METHOD

INTRODUCTORY.—The ordinary method for the estimation of tin by reduction of a stannic salt in hydrochloric acid solution by means of iron or nickel, and the titration of the stannous chloride thus formed with iodine, gives satisfactory results with fairly large amounts of tin. When, however, the quantity to be estimated amounts to only a few milligrams it becomes extremely difficult to avoid various sources of error.

In order to estimate minute differences it is necessary to use a weaker iodine solution than that commonly employed, hence traces of impurity which have an action on iodine cause more serious errors. Moreover, with extremely dilute solutions of stannous chloride it is difficult to maintain the tin in the stannous condition after reduction, during the cooling necessary before titrating with iodine. Oxidation is liable to take place on introducing the starch indicator and some attempt is usually made to maintain an atmosphere of CO_2 above the liquid before and during titration, by the introduction of a small piece of marble or a little sodium bicarbonate into the solution immediately after reduction. This is not always effective, and may be the means of introducing undesirable impurities.

EXPERIMENTS ON TITRATION OF SMALL AMOUNTS OF TIN BY IODINE.—In order to test the degree of accuracy obtainable by the ordinary method of titration, the following solutions were prepared :—

Stannic Chloride: 0·5 grm. pure tin dissolved in 10 cc. conc. HCl with addition of 0·33 grm. $KClO_3$; solution boiled for some time and diluted to 500 cc. (1 cc. of this solution = 1 mgr. Sn).

Iodine Solution (Iodine in KI) approximately $\frac{N}{90}$ (1 cc. solution = 0·66 mgr. Sn).

Starch emulsion prepared with addition of a little NaOH as a preservative.

Method.—Measured quantities of the tin solution were acidified with HCl so as to obtain about 1 volume of conc. HCl in 4 volumes of solution. 4 or 5 small clean iron nails were introduced and the mixture heated to boiling in a conical flask, in the mouth of which was placed a funnel containing a small piece of marble. The liquid was then kept near boiling point, for the required time necessary for complete reduction, usually 10 to 15 minutes. The flask was then rapidly cooled under the tap, the marble and a little starch emulsion added, and the liquid titrated without removing the nails.

The results are shown in Table 1.

TABLE 1

Tin Solution taken. cc.	*Sn* mgr.	*Conc. HCl Added.* cc.	*Iodine required.* cc.	*Tin found* Sn mgr.
10	10	3	15·0	9·9
20	20	6	30·1	19·9
30	30	9	44·15	29·1

Ten minutes heating in each case.

TESTS WITH MORE DILUTE SOLUTIONS.—The above results appeared to be fairly satisfactory, except that there was a tendency for the blue starch colour to fade rapidly after the titration, so that in some cases the exact end-point was uncertain. It was thought that this might be due to some carbon compound introduced by the iron nails. Pure iron wire, as used for standardizing solutions, was therefore employed in the following tests.

Some experiments were made in which H_2SO_4 was substituted for HCl, but this showed no perceptible advantage. The solutions used were :—

Stannic Chloride. The previous solution diluted so that 1 cc. = 0·1 mgr. Sn.

Iodine. 1 cc. = 0·637 mgr. Sn.

About 1 grm. of iron wire was used in each test. Heating was continued for 10 to 15 minutes. The end-point was perfectly sharp. The results obtained are shown in Table 2.

TABLE 2

Tin Solution taken. cc.	*Sn.* mgr.	*Conc. HCl.* cc.	*Iodine required.* cc.	*Sn found.* mgr.
10	1	6	1·55	1·06
20	2	6	3·1	1·97
30	3	10	4·65	2·96
40	4	13	6·3	4·01
50	5	17	7·95	5·06

Attempts were made to titrate still smaller quantities of tin (0·1 to 1 mgr.) by this method, but it was not found practicable,

probably on account of the interference due to small quantities of impurity in the iron or other reagents used.

Reduction with Nickel.—As it was thought that better results might be obtained by the use of pure nickel in place of iron, a quantity of the purest obtainable sheet nickel was cut into strips and coiled spirally, 0·5 to 1 grm. being added for each test. The reagent was apparently unattacked by HCl (1 : 3) in the cold, and all appearance of action ceased after cooling, at the end of the operation. The titration was therefore made in the presence of the nickel coils. The final solution was greenish but the change to the starch blue could be seen without difficulty. The tests were carried out otherwise as already described, but heating was continued for 20 minutes. The solutions used were :—

Stannic Chloride. As before, 1 cc. = 0·1 mgr. Sn.

Iodine Solution 1 cc. = 0·1405 mgr. Sn.

This solution was much weaker than that used in the previous series of tests.

The results are shown in Table 3.

Table 3

Tin Solution taken	*Sn.*	*Conc. HCl.*	*Iodine required.*	*Tin found.*
cc.	*mgr.*	*cc.*	*cc.*	*mgr.*
10	1	10	7·0	0·98
20	2	10	14·9	2·09
30	3	10	20·5	2·88
40	4	15	28·75	4·04

Another series of tests was made, with 10 min. boiling, the results being set out in Table 4. Iodine solution used :—1 cc. = 0·1465 mgr. Sn.

Table 4.

Tin Solution taken.	*Sn.*	*Conc. HCl.*	*Iodine required.*	*Tin found.*
cc.	*mgr.*	*cc.*	*cc.*	*mgr.*
10	1	10	6·75	0·99
20	2	10	13·55	1·98
30	3	15	19·35	2·83
40	4	15	29·55	4·33

Influence of Time.—Further experiments were made, using nickel coils as before, to determine the influence of time on the result. The maximum reduction was obtained with 15 to 20 minutes' heating, measured from the time when boiling began. The solutions were kept hot, near the boiling point but not actually boiling, until the finish. Starting with 1 grm. nickel in each case, about 0·25 grm. was dissolved in 10 minutes, and about 0·5 grm. in 25 minutes. Iodine Solution used : 1 cc. = 0·0862 mgr. Sn. The results are shown in Table 5.

Reduction with Antimony.—Attempts were made to use finely powdered metallic antimony as the reducing agent, but it was found that the end-point could not be observed in presence of the suspended antimony, and that it was impracticable to filter it off before titration, owing to rapid oxidation of the $SnCl_2$.

PART II.—COLORIMETRIC METHOD

Introductory. — As the volumetric method did not appear to be very suitable for estimating minute quantities of tin—of the order of 0·1 to 1 mgr.—experiments were made with a view to utilizing the blue colour given by stannous salts with ammonium molybdate as a colorimetric test. The reaction is extremely delicate.

Unfortunately, a similar colour is given by many other reducing agents, such as ferrous sulphate, ferrous chloride, sulphur dioxide, sodium amalgam and nascent hydrogen evolved by metals such as iron, nickel and antimony in contact with acids. It is therefore necessary in most cases to isolate the stannous salt from all other reducing agents before applying the test.

No colour is given by HCl alone, even when concentrated, in fact the colour is destroyed by a large excess of HCl as also by an excess of ammonia or caustic alkali.

Table 5

Tin solution	*Sn.*	*HCl. conc.*	*Water.*	*Time.*	*Iodine required.*	*Sn. found*
cc.	*mgr.*	*cc.*	*cc.*	*min.*	*cc.*	*mgr.*
10	1	10	20	10	8·5	0·72
20	2	10	10	10	22·5	1·94
30	3	10	—	10	32·9	2·84
10	1	10	20	15	13·3	1·15
20	2	10	10	15	23·1	1·99
30	3	10	—	15	32·3	2·78
10	1	10	20	20	12·4	1·07
20	2	10	10	20	23·4	2·02
30	3	10	—	20	34·4	2·97
10	1	10	20	25	12·7	1·09
20	2	10	10	25	23·1	1·99
30	3	10	—	25	33·3	2·87

It was found that the best method for producing the required tint is to pour the reduced solution (generally prepared by boiling with HCl (1 : 3) under conditions described below) into a solution of ammonium molybdate containing sufficient free alkali to neutralize a part of the excess acid.

Reduction of the Tin Solution.—It is obvious from the above, that the ordinary methods of reduction with iron, nickel or antimony are unsuitable, as in each case a product is formed which itself has the property of producing a blue colour with the molybdate reagent. It was necessary, therefore, to find some reagent which would effectively reduce the tin to the stannous condition without yielding any product which would itself react with the molybdate. Various substances were tried, and in each case a blank test was made without tin salt, but otherwise using the same reagents and the same treatment. Fairly good results were obtained with metallic copper and still better with amalgamated copper, prepared by cleaning coiled strips of copper foil with nitric acid and agitating with sodium amalgam and dilute HCl. For the reduction, the prepared strips were heated with a measured volume of the stannic chloride solution, diluted with water and acidified with HCl in the proportion of 1 part conc. HCl in 4 parts of liquid. After the solution had been kept at or near boiling for 5 to 10 minutes it was decanted into a wide test tube containing, usually, 10 cc. of a solution of ammonium molybdate and sodium hydroxide. The blank tests gave only a faint colouration, and the intensity of colour increased with increasing quantities of tin. It was found finally, however, that much more satisfactory results could be obtained by the use of lead foil.

Reduction with Lead Foil.—Pure assay lead foil was cut into thin strips and rolled into coils, 3 of these strips weighing approximately 1 grm., and this was found to be a suitable quantity for reduction under the given conditions.

The following solutions were prepared :—

Stannic Chloride.—50 mgr. (0·05 grm.) pure tin dissolved in 25 cc. conc. HCl by warming gently with addition of 0·1 grm. potassium chlorate, then boiling until colourless ; a further 25 cc. conc. HCl was then added, boiled, cooled and diluted to a total volume of 500 cc. by the addition of distilled water (1 cc. = 0·1 mgr. Sn).

Ammonium Molybdate.—10 grm. of crystallized ammonium molybdate was dissolved in water, 200 cc. of 2*N*. NaOH added and the whole diluted to 300 cc. This represents a solution of 3·33% $(NH_4)_2MoO_4$ and 5·33% NaOH. 10 cc. of this was taken for each test.

It was found later that equally good, if not better results could be obtained with a solution containing 1%, $(NH_4)_2MoO_4$ and 2% NaOH.

Method of Testing.—The required quantity of the stannic chloride solution (1 to 10 cc.) was measured from a burette into a small conical flask. Conc. HCl and water were then added, so that the amount of conc. HCl was 25% of the total volume. (For amounts of 10 cc. stannous chloride or less, the total volume used was 20 cc.) The lead foil was then added and the solution heated to boiling. It was allowed to boil gently for a specified time, generally 5 or 10 minutes, and at once decanted into a tube containing 10 cc. of the standard molybdate ; the lead foil was rinsed once or twice with distilled water, which was also decanted into the tube, making the total volume in the latter up to 40 cc. The liquid was then stirred or poured into another vessel to mix thoroughly, and the tube corked. The blue colour develops immediately and is apparently quite permanent, for at least a month, if protected from the air in a corked tube.

Immediately on exposure to the air an iridescent film forms on the surface of the lead foil, but this is dissolved in the water-washing. The same lead turnings may be used repeatedly for successive tests if carefully cleaned, immediately before use, by warm dilute HCl followed by distilled water.

A series of tests containing 1 to 10 cc. of the stannic chloride solution (i.e. 0·1 to 1 mgr. Sn), run in this way, should show a regularly increasing intensity of colour. It is generally possible to detect a difference in tint between tests differing by 0·1 mgr. of Sn when the total amount does not exceed 1 mgr.

Factors affecting the Colour of the reduced Molybdate Solution.—It was found that the degree of acidity of the final solution had a marked effect on the nature and intensity of the colour produced. When the standard molybdate is too alkaline the tests show a greenish tint and are considerably paler than when the proper conditions are obtained. This is especially the case with the smaller amounts of tin, say 0·1 to 0·3 mgr. It was not found possible to correct

this by the addition of acid after the solutions had been mixed. With an unknown solution it might be necessary to experiment with varying additions of alkali to the standard molybdate in order to secure the best conditions for the development of a pure blue colour of maximum intensity.

The presence of other reducing agents, such as ferrous salts, of course vitiates the test. The solution must also be carefully protected from oxidation during and at the end of the reduction process. This was generally secured by placing a small funnel in the neck of the boiling flask, and arranging so that evaporation was kept at a minimum. The lead foil should not become exposed until the operation is completed. The flask used should therefore be of such a size that a good layer of liquid covers the lead at all times. After reduction, the liquid should be poured into the molybdate solution with as little delay as possible.

Apparently the molybdate reaction takes place equally well in hot or cold solution.

Separation of Tin from various impurities before applying Colorimetric Test.—As already pointed out, it is generally necessary to isolate the tin before applying this test. Certain elements however, such as zinc, need not be separated as they have no effect on the colour reaction.

Separation from Iron.—The regular separation by means of H_2S might be used, but it was found more convenient to precipitate the tin in the metallic state by means of zinc. Pure stick zinc was rolled into thin strips about $\frac{1}{32}$ in. thickness, by passing between carefully-cleaned steel rolls. This was cut up into short lengths and about 1 grm. used for each test.

The solution containing iron and tin as chlorides was neutralized with NaOH until a slight precipitate was formed; this was dissolved by gradual addition of $2N \cdot HCl$ added until a clear solution was obtained, the total volume being about 25 cc. The zinc was then added, the mixture heated to boiling and the action allowed to proceed with occasional agitation, but without further boiling, for about 5 minutes. By this means the tin is completely deposited on the zinc as an adherent film, with no loose particles, and the zinc is not disintegrated.

The liquid is then poured away and the zinc washed at least three times by decantation with distilled water, thus removing all iron. 20 cc. of HCl (1 : 3) is added and heated until the zinc, with deposit of tin, is completely dissolved. About 1 grm. of lead foil in the form of small coils, is then added and boiled gently for 5 minutes. The liquid is poured into 10 cc. of the standard molybdate, made up to 40 cc. and the tint compared with standards containing known amounts of tin.

This procedure likewise separates the tin from any other metals such as Al, Mn, Mg, etc. which are not precipitated by zinc in HCl solution.

Separation from Copper.—Copper and other metals which might be precipitated on zinc together with the tin may generally be removed by a preliminary treatment with lead foil, the operation being repeated, in slightly acid (HCl) solution until no further deposit of copper is obtained on fresh lead foil. If iron and other similar impurities are absent, the liquid may then be poured at once into the standard molybdate as any tin will be in the stannous condition. In presence of iron it is desirable, after the above treatment for removal of copper, to precipitate most of the lead by the addition of dilute H_2SO_4, filter, neutralize with NaOH and acidify slightly with HCl. The tin is then precipitated on zinc, dissolved and treated as described above under separation from iron. If the dissolved lead is not removed in this way it forms a spongy deposit on the zinc which prevents the deposition of the tin in an adherent form.

Separation from Arsenic and Antimony.—Moderate amounts of these elements may easily be removed by boiling in dilute HCl solution with copper turnings, tin and other metals remaining in solution. When no more black deposit is formed on addition of fresh copper foil, the liquid is poured off, the copper removed by means of lead foil as above described, and the solution, now containing tin in stannous condition, treated at once with the standard molybdate.

After any of the above separations, the acidity of the final solution should be adjusted so as to correspond approximately with that of the standards, that is, there should be about 1 volume of conc. HCl in 4 volumes of liquid.

Summary.—Quantities of tin of the order of 0·1 to 1 mgr. may be detected and approximately estimated by the colorimetric method as follows. The material is obtained in a hydrochloric acid solution. Arsenic and antimony, if present, are removed by precipitation on copper; copper by precipitation on lead. If iron or similar metals are present the tin is precipitated from a very slightly acid solution by deposition on

metallic zinc ; this is then washed and the zinc with deposit dissolved in HCl (1 : 3). The solution is reduced by boiling for 5 to 10 minutes with lead foil and the liquid at once poured into 10 cc. of a slightly alkaline solution of ammonium molybdate (say 1% ammonium molybdate with 2% sodium hydrate). The intensity of the blue colour indicates the quantity of tin present.

ACKNOWLEDGMENT. — The writer again desires to express his thanks to the authorities of the Chelsea Polytechnic for facilities accorded in carrying out an extensive research on this subject. Only a very small part of the experimental work undertaken is recorded in this paper, as a very large number of tests were necessary to determine the best conditions of working.

EMPIRE MINING AND METALLURGICAL CONGRESS

Held in South Africa during March, April, and May, 1930

FROM OUR OWN CORRESPONDENT

JOHANNESBURG TO RHODESIA AND THE RETURN[1]

Travelling due west from Johannesburg in special trains the delegates to the Empire Mining and Metallurgical Congress passed through South Africa's principal tobacco, fruit, and cotton growing area and several small towns, including Zeerust, which is the centre of an area noted for several minerals, including zinc, lead and fluorspar. At Mafeking, the famous siege town, where there is one of the oldest diamond diggings in the Union, the railway joins up again with the route to the north and the travellers were taken through flat, open country and into the Bechuanaland Protectorate. For five hundred miles they were in view of the edge of the Kalahari desert and from the carriage window there was nothing to be seen except sand, bush and groups of natives assembled at wayside stations to sell quaintly carved images, skins and karosses. After leaving Francistown, the chief township in the Tati Concession, where there are several small gold mines, the railway climbs the southern slope of the Limpopo-Zambesi watershed and the views become more extensive. At the Ramaquabane River the tourists entered Rhodesia and soon afterwards Bulawayo was reached.

Motor cars were waiting at the station to convey the visitors to the Prince's Kinema Hall which was the headquarters of the Congress while in Bulawayo. Sir James G. McDonald, President of the Rhodesia Chamber of Mines, presided over the technical session which was opened by the Governor of Southern Rhodesia, Sir Cecil Rodwell. The members of the Congress attended a civic luncheon and reception at the Drill Hall, and during the afternoon visits were made to local places of interest.

On the following day the visitors arrived at Wankie, and inspected the large collieries which supply the Rhodesias and the Belgian Congo with coal.

Broken Hill was reached on the night of April 11. After passing through many miles of dark, uninhabited bush country the visitors were struck by the contrast when their train came to rest in the heart of a large works with its brilliantly lighted buildings and tall smoke stacks. They

[1] The photographs illustrating this article are published through the courtesy of Mr. E. J. Membrey.

remained in the train during the night. Next morning the party were early on the move and started the programme which had been prepared for them by the local committee by a meeting in the New Club Hall at 8.45 a.m. Here they were handed programmes with full particulars of the tours that had been arranged, together with copies of flow-sheets illustrating the sequence of operations on the plants they were to visit. The visitors then divided into eight parties, according to a prearranged plan, for a tour of the works, each party working independently of the others and accompanied by its own guide. At various points through the plant demonstrators were stationed who explained to each party as it arrived the operation of that section of the plant. In the main offices was seen an interesting series of technical exhibits, including a case of beautiful specimens of minerals for some varieties of which Broken Hill has become famous. Among them were bones from the Broken Hill Bone Cave surrounding a replica of the skull of Homo Rhodesiensis.

Luncheon was taken at the Country Club, where the members of the Congress were received in the quaint thatched pagoda by the Governor of Northern Rhodesia (Sir James Maxwell) and Lady Maxwell.

After lunch His Excellency welcomed the visitors to Northern Rhodesia, saying that at one time he had hoped to welcome them at the present capital of the territory, Livingstone, although it was probably more appropriate that they should be received in Broken Hill, the oldest established and for many years the only large mining enterprise in Northern Rhodesia. Broken Hill had emerged from a cloud which had for a time surrounded it. He wondered if mining men realised that when they came to countries such as this they were doing a great missionary work among the native people. He had known these people many years and liked them. Mining men, with their examples of sanitation, were in his and many other ways setting an invaluable example. They showed these people what could be achieved by good, hard, efficient work.

One of the other speakers at the luncheon, Mr. F. S. Mance, Under-Secretary for Mines, Australia, said their tour that day had been most instructive and interesting. He had heard that T. G. Davey, when he discovered these deposits of lead and zinc, had named the place Broken Hill after the great lead and zinc mines at the original Broken Hill, in Australia. The original had since its discovery in 1885 produced metal to a total value of £144,000,000, of which £35,000,000 had been distributed as dividends to shareholders. He did not think that he could wish this Broken Hill in Rhodesia anything better than that it would do as well.

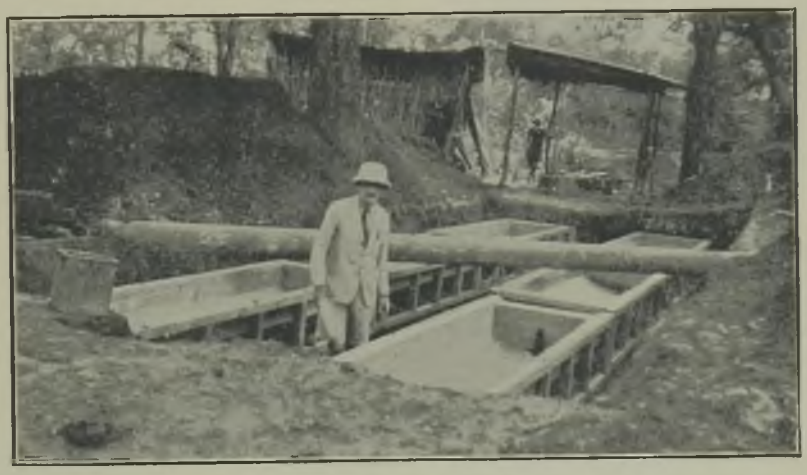
Reception of Delegates at the Country Club, Rhodesia Broken Hill.

A party of 40 of the visitors left by car for a trip to the company's hydro-electric works at Mulungushi, the remainder returning to Broken Hill, to complete their tours of the mines and plant.

Most of the tourists saw the Bwana M'Kubwa, at present the only producing copper mine in Northern Rhodesia, and at least one of the following mines, Roan Antelope, N'Kana, N'Changa, Mufulira and others.

On their return journey they spent two days at the Victoria Falls and one at Bulawayo, and all visited Cecil Rhodes's grave in the Matoppos. About 40 members of the Congress, instead of going to the copper belt, visited Salisbury and some of the gold and asbestos mines of Mashonaland.

During the run back to Johannesburg, the special trains were held up for some hours owing to the derailment of a goods train. A brief stay in Johannesburg, which city the tourists were glad to see again, and then the members of the Congress paid a visit to the world's largest diamond mine—the Premier, after which they spent the rest of the day in Pretoria, the administrative capital of the Union. The Government buildings were greatly admired.



Sludge Tanks for Diamond Drilling, Roan Antelope.

From Pretoria the delegates started on a long tour through the Eastern Transvaal, visiting the coalfields of the Middelburg district, the Pilgrims Rest goldfield, the Barberton asbestos field, the Kruger National Park—otherwise known as the Sabie Game Reserve—and other places of interest. The Kruger National Park provides a spectacle, or rather a series of spectacles, such as only Africa can show. Within a sanctuary of some nine thousand square miles practically every species of big game for which the country is noted roam at large in a habitat as primitive as it was thousands of years ago. The fact that a party can motor near enough to the animals to get good pictures is proof of the confidence of the inmates.

In Natal, which has been called the garden province of the Union, on account of the fertility of its well-watered soil and the beauty of its scenery, the members of the Congress visited or passed through several towns which, apart from present claims to note, have behind them a history that has long since brought them fame—Glencoe, Ladysmith and Colenso are landmarks in South African history. Famous battlefields once, they are now peaceful and progressive towns growing steadily as a result of coal mining and general farming enterprises. The border town of Newcastle, in addition to being a noted coal mining centre, is the site of important iron and steel works, the ore being brought from large deposits in the adjoining Dundee district. Coal of practically all qualities and characteristics is found in this part of Natal, ranging from highly bituminous to anthracite. In some portions of the Klip River field the coal is worked at depths down to 600 feet.

At Colenso is situated on the bank of the Tugela River, where a battle was fought between Briton and Boer, the power station that supplies energy for the electrified track along which coal is conveyed to Durban, the port of export, where modern coaling and storage plants have been installed.

Some of the most beautiful scenery in Natal includes the Howick Falls, the wooded hills overlooking Pietermaritzburg, and the Valley of a Thousand Hills, situated between Pietermaritzburg and Durban.

The tourists found much to admire at Durban, which is one of the Union's most popular winter holiday resorts. Sugar and fruit plantations line the coast north and south of the port along a belt that extends nearly 300 miles.

STEAM-SHOVEL AT BWANA M'KUBWA.

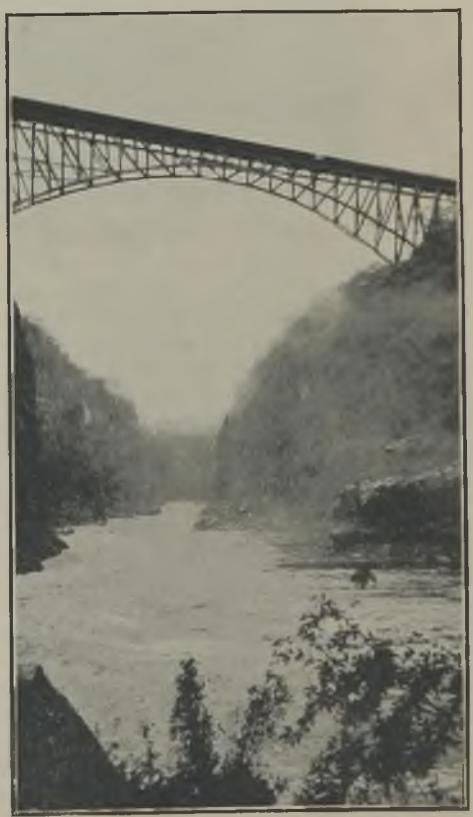
In the ascent from the Natal coast to the Orange Free State plateau, the visitors passed over the Van Reenen's Pass, an inspiring highway through the Drakensberg (Mountains of the Dragons), where the scenery is exceedingly impressive. Leaving Bloemfontein, the capital of the Orange Free State, they travelled through the south-eastern portion of the Karroo to Port Elizabeth, another popular holiday resort, then through the "Ostrich Land" of South Africa, the centre of which is the picturesque town of Oudtshoorn. The pretty villages of George and Knysna were greatly admired, also "The Wilderness" which is a wilderness in a name only, but actually a holiday resort of bewildering beauty.

There was more very attractive scenery to be admired along what has been called "The Garden Route" which constituted the last lap of the 7,000 miles tour round Southern Africa of those who attended the third Empire Mining and Metallurgical Congress.

Before their departure from Capetown the delegates declared that no praise was too high for those concerned in the inception and arrangements of the Congress, and expressed their hearty thanks to all concerned, and for the hospitality they experienced throughout the tour.

All the delegates have commented very favourably on the technical efficiency of the Rand and the keenness of those in control of mining and metallurgical operations. A striking point which impressed everyone was the wonderful spirit of cooperation which exists not only between the various mines of the same group, but between all the mines, and the opinion was expressed that this was only made possible by the small but very remarkable group of young men—the consulting engineers—whose personalities were most inspiring and whose knowledge of detail was profound. The activities of the Transvaal Chamber of Mines with regard to recruiting health and sanitation also created a deep and very favourable impression and the delegates admitted that they had learned much during their visit and were going away full of useful ideas.

With regard to Northern Rhodesia, while all were agreed that the magnitude of the copper deposits had not been exaggerated, the view was expressed that only success could justify a general mining policy which runs counter to accepted principles. Probably production will not eventuate according to programme, but this is not of much moment in view of the present low price of copper.



ZAMBESI BRIDGE, VICTORIA FALLS.

THE PETROLEUM INDUSTRY

By HENRY B. MILNER, M.A., D.I.C., M.Inst. P.T.
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The author summarizes the present position of the industry throughout the world.

Nothing stagnates in the oil industry, though latterly it may have seemed that quiescence reigns in succession to the swiftness of events, culminating in the United States' production attaining within 60,000 barrels of the 3,000,000 daily mark last August. The lull may be more apparent than real, but it proved too much for one enterprising American writer, who, visiting the Wietze district of Hanover discovered that the first German oil-well was drilled during March and April, 1859, thus antedating Drakes's famous Pennsylvanian well by a few months, so that even cherished tradition is not inviolable in this industry. Incidentally that German well still produces, a remarkable record of longevity.

The American oil situation is complex. Interest is torn between internal economics, such as the merger of the Standard Oil Company of New York (" Socony ") and the Vacuum Oil Company, conservation schemes on trial in certain States, the Federal Oil Board's endorsement of " unit operation " for economic exploitation of oil pools, and the slight but certain decline shown in the U.S. share of world production. For years past America, by virtue of her vast resources and developments, has been the focus of the industry as a whole ; now that condition is altering and Americans are as alive to it as are their foreign competitors. Since the end of the War their desire to exploit petroleum in other countries has been emphasized by their keen activities in this direction—e.g., in Venezuela, Iraq, and the East Indies. In contrast to-day is the fear, openly expressed in many quarters, that the rapid rehabilitation of Russia's oil industry may actually lead to petroleum exports from that country to Atlantic markets, a curious swing of the pendulum, if and when it comes to pass. The fruits of the international agreement to check useless competitive and long-distance transport of oil are now perceptible and the logic of feeding world markets from fields favourably situated thereto cannot be gainsaid, but an independent, determined Russia, competing on the basis of ever-increasing resources, might do much to upset what measure of stability has already been achieved. Technically, the principal factors in contemporary American developments are increased accuracy of geological exploration for buried structures, reinforced by successful geophysical prospecting, deep drilling consequent on great engineering improvements, with 10,000 ft. holes practicable in the near future, the discovery of deep pools hitherto inaccessible, oil-well deviation and surveying, and the rejuvenation of old fields by various repressuring methods. The gas-oil ratio is no longer regarded as an academic flight, but is now a concrete, if much abused, entity in economic field-development. All this applies, to a greater or lesser extent, to the major oilfields of the world. Mexican production has settled down as rather a routine proposition, with a decline in favour of Venezuela, Russia, and the Dutch East Indies ; considerable exploratory work is in progress in the north and in the Tehuantepec zone, and a Protrero No. 4 might burst forth at any moment, just as the salt water bogey will be revived if routine is too long undisturbed. In Venezuela the Maracaibo coast fields still dominate the situation, though inland developments in Falcon have been very promising ; there is comparatively little territory around the lake, eastward in Falcon and along the northern Orinoco belt not being attacked geologically at some point or other, and the interests behind these ventures are truly cosmopolitan. The other South American republics pursue serenely their oily tenor, though recent expropriation threats by the Argentine government cause some uneasiness at Comodoro.

Search for oil in the Empire moves steadily, but Nature has, perhaps, not bestowed this blessing as lavishly as she might have done in the territories concerned. Canada has bestirred herself with the prospects of Turner Valley, a field bristling with technical contradictions, but none the less a welcome discovery, one which gives Alberta a lead in the realm of future promise. Trinidad produces about 100,000 tons per month, a firm yield ; here again exploration for oil is active, especially in the south-east, while geology in the island still thrives on acute controversy, a healthy sign. We are not impressed with recent attempts to revive oil prospecting in British Guiana. Somehow

diamonds and petroleum seem mutually exclusive. Egyptian oil is another case of routine without incident, while there are yet optimists prepared to back the chance of finding oil in South Africa, where further developments are now proceeding. Of the Indian fields, Yenangyaung (Burmah) is still the bright star, an outstanding example of efficient organization and control. Geological survey both in Burmah and in Assam is being vigorously prosecuted. Sarawak has done much to contribute to the important position held by the East Indies in world-production, the famous Miri field still holding sway. Indications in Brunei (British Borneo) are encouraging. In New Guinea (Papua) reconnaissance of favourable areas has been carried out in past years largely at the behest of the Australian government. With enigmatical prospects and a tightening of the purse-strings it looks as though this island's oil developments will have to lie fallow for a while. The subject of indigenous Australian oil continues provocative in financial, political, and technical circles in the Commonwealth ; what a pity to waste so much time and money over ephemeral resources. Much the same may be said, though with far less ground for criticism, of New Zealand.

Europe is experiencing a great urge to find oil in nearly all its constituent countries. Germany goes forward optimistically with the co-operation of American interests, technical and otherwise. Recently a 700-bl. flowing well was brought in near the old field at Oelheim. France, recognizing that possibilities of internal oil supplies on a commercial scale are remote, has concentrated efforts on securing facilities for refining crude oil, not only that ultimately won from Iraq, but also from other sources. Poland is engaged on a complete revolution of technique, both geological and engineering. The lessons learnt in unravelling southern Carpathian structures are being applied in this more northern zone, while American influence and equipment are fast displacing the ancient system of drilling and crude production methods so long practised in that country. Roumania has put her petroleum house in order in every technical department. Her present, as her future, is bound up with deep sand location and with prospects elsewhere in Wallachia and Moldavia. Russia is no longer an unknown quantity in the oil situation. The Soviet government has realized from the first that money is a forceful argument against even the deepest international prejudice, and no effort has been spared to re-organize the industry at Grozny, Maikop, and Baku, by the introduction of up-to-date plant, modern methods of prospecting (including geophysical), the laying down of new refineries (e.g., Touapse, Black Sea), and pipe-lines, while the recent discoveries of oil in the province of Perm, western Urals, and the entry into production of Saghalienneft are all important factors in the Russian scheme of things.

Of the remaining Asiatic fields, Iraq provides a good example of organized international exploration and, incidentally, of virgin shut-in production It is the " x " of the Mediterranean equation, whose solution can only be found in terms of a prodigious pipe-line scheme and compromise as to route and sea-board terminal. Persia continues high on the list of producing countries and the main field, Masjid-i-Sulaiman, now possesses a substantial " offset " in Haft Kel ; clearly the oil resources of this territory have only been scratched. Americans and others interested in " unit operation " policy would do well to study the Persian oilfields which are a monument to efficient organization and development. Increased production is recorded for the East Indies (Sumatra, Java, Ceram, and Borneo) following on active drilling last year, while the fortunes of " Niam " (Nederlandsch Indische Aardolie Maatschappij, in which the Dutch government is interested) are already in the ascendant with recent discoveries of oil near Tarakan. In short, in the realm of petroleum, progress is the key-note of current happenings. Though the industry has its " ups and downs " and its economic difficulties, the outlook is decidedly good so long as there is the will to international co-operation to prevent waste and, of equal importance, to exploit this commodity with the highest possible technical efficiency.

Institution's Annual Dinner.—The annual dinner of the Institution of Mining and Metallurgy, which, as announced in the MAGAZINE last month, was to have been held on June 26, was cancelled and is not taking place this year. The arrangements for this function are in the hands of the Secretary, who only returned from South Africa a few weeks before the date mentioned, and there was at the last moment insufficient support forthcoming.

THE EARTH-RESISTIVITY METHOD OF ELECTRICAL PROSPECTING

By E. LANCASTER-JONES, B.A.

(*Concluded from the June issue, p. 355.*)

MATHEMATICAL THEORY OF POTENTIAL DISTRIBUTION IN EARTH RESISTIVITY CIRCUITS.—As has previously been stated, the Gish-Rooney assumptions regarding the theory of electrical distribution in the earth, when a current introduced at one electrode leaves the ground at a second, require critical examination. In particular, the assumption that, corresponding to a certain electrode spacing a, the effective depth of penetration is equal to this interval is not valid when the specific resistance of the ground is not constant, but varies—for example with depth. As such variation is in practice the rule and not the exception—indeed were this not the case, the method would have no application to prospecting—it is necessary to develop a rigid theory as a basis for correct practical application and interpretation. There is no difficulty in effecting this, as the problem is analogous to certain well-known problems of electrostatics. Whilst exact analytical solutions can only be obtained for a few special cases, these are sufficiently instructive to serve as the basis for determining correct procedure in more general problems.

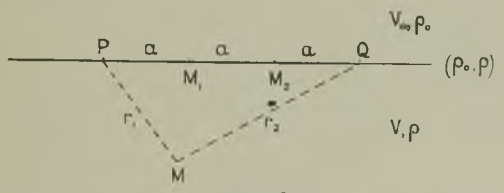


FIG. 3.

Fundamentally stated, the problem is as follows (see Fig. 3). Given a point "source" of electricity at P in the plane surface which separates two media of different specific resistivities, ρ_0 and ρ, and an equal "sink" of electricity at a second point Q, also in the separating plane; to find the potentials V_0 and V respectively at any point in the two media. The first case to be considered is the most simple, namely, when the two media are of infinite extent, so that no other boundary surface besides the separation surface comes into consideration, and the resistivity ρ_0 is infinite (e.g. the medium is air). According to the well-known laws of the conduction of electricity in three dimensions, we have the following conditions to be satisfied. V_0 and V at any point other than the source P and the sink Q must satisfy Laplace's Equation

$$\nabla^2 V = 0.$$

If the total current entering medium ρ at P and leaving it at Q is I, then, in the neighbourhood of P and Q the total current flow through a hemispherical surface of small radius centred at each of these points must be equal to I. The potential and current must become zero at an infinite distance. The current flow in the two media near the surface of separation must be continuous—otherwise there will be an accumulation of electricity at the surface. Also since $\rho_0 = \infty$, there is no flow across the surface of separation. Now, if M be any point in the medium ρ, at distances r_1 and r_2 respectively from P and Q, it can be shown that the formula

$$V = \frac{I\rho}{2\pi}\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

satisfies all the above conditions. Hence this formula gives the correct solution for the potential function in the medium ρ, whilst, as there is no current flow at all in medium ρ_0, $V_0 = 0$.

If the distance PQ $= 3a$, at points M_1 and M_2, trisecting the line PQ we have, for M_1, $r_1 = a$, $r_2 = 2a$, and for M_2, $r_1 = 2a$, $r_2 = a$.

$$\therefore\ V_1 \text{ (at } M_1) = \frac{I\rho}{2\pi}\left(\frac{1}{a} - \frac{1}{2a}\right) = +\frac{I\rho}{4\pi a}$$

$$V_2 \text{ (at } M_2) = \frac{I\rho}{2\pi}\left(\frac{1}{2a} - \frac{1}{a}\right) = -\frac{I\rho}{4\pi a}$$

$$\text{whence } V_1 - V_2 = \frac{I\rho}{2\pi a}$$

$$\text{and } \rho = 2\pi a \frac{(V_1 - V_2)}{I}$$

As, in earth-resistivity measurements, M_1 and M_2 correspond to the two inner electrode positions, where the potential difference is measured, it is evident that this equation is the basis of the Gish-Rooney method, which, for a medium of uniform density ρ is a strictly valid formula.

We shall next consider the case when a second parallel place surface, at a distance h,

separates the medium ρ from a third medium, of different specific resistivity ρ', which may be greater or less than ρ (Fig. 4). The potential V, for the region ρ, has now to satisfy all the previous conditions, together with a further set of conditions valid at the separating surface (ρ, ρ'). At this surface also there must be no accumulation of electricity.

Let the ratio $\frac{\rho' - \rho}{\rho' + \rho}$ be denoted by k.

Let P_1 denote the point which is the image, or reflection, of P in surface (ρ, ρ'), and let P'_1 denote the point which is the reflection of P_1 in the surface (ρ_o, ρ).

Then the distances PP_1 and PP'_1 each equal 2h.

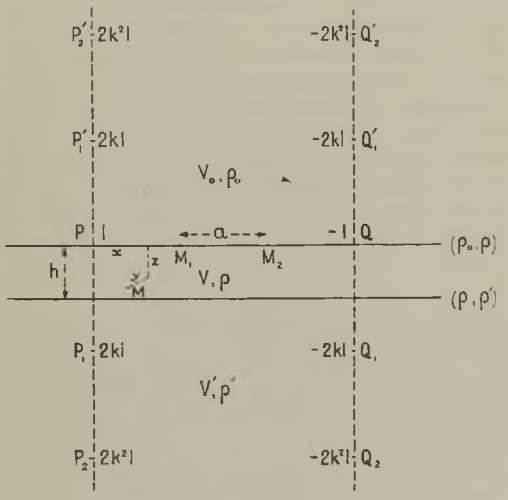


FIG. 4.

Similarly, let Q_1 and Q'_1 be corresponding images of Q in the two surfaces of separation.

Imagine sources of electricity of magnitude 2kI at P_1 and P'_1, and sinks of electricity of magnitude $-2kI$ at Q_1 and Q'_1.

Now conceive the potential, at a point M in the region V, as made up of the separate potentials due to each of these three sources and three sinks.

If M has the co-ordinates (x, y, z) referred to P as origin, the line PQ as axis of x, and the line PP_1 as axis of z, then the distances

$$PM = \frac{1}{\sqrt{x^2 + y^2 + z^2}},$$

$$P_1M = \frac{1}{\sqrt{x^2 + y^2 + (z - 2h)^2}},$$

$$P'_1M = \frac{1}{\sqrt{x^2 + y^2 + (z + 2h)^2}}.$$

$$QM = \frac{1}{\sqrt{(3a - x)^2 + y^2 + z^2}},$$

$$Q_1M = \frac{1}{\sqrt{(3a - x)^2 + y^2 + (z - 2h)^2}},$$

$$Q'_1M = \frac{1}{\sqrt{(3a - x)^2 + y^2 + (z + 2h)^2}}.$$

And the sum of the potentials due to the series of three sources and sinks is,

$$V = \frac{I\rho}{2\pi}\left\{\left(\frac{1}{PM} - \frac{1}{QM}\right) + k\left(\frac{1}{P_1M} - \frac{1}{Q_1M}\right) + k\left(\frac{1}{P'_1M} - \frac{1}{Q'_1M}\right)\right\}.$$

For the point M_1, for which $x = a$, $y = 0$, $z = 0$, we have

$$V_1 = \frac{I\rho}{2\pi}\left\{\left(\frac{1}{a} - \frac{1}{2a}\right) + k\left(\frac{1}{\sqrt{a^2 + (2h)^2}} - \frac{1}{\sqrt{(2a)^2 + (2h)^2}}\right) + k\left(\frac{1}{\sqrt{a^2 + (2h)^2}} - \frac{1}{\sqrt{(2a)^2 + (2h)^2}}\right)\right\}$$

$$= \frac{I\rho}{4\pi a}\left\{1 + 4k\left(\frac{1}{\sqrt{1 + \left(\frac{2h}{a}\right)^2}} - \frac{1}{\sqrt{4 + \left(\frac{2h}{a}\right)^2}}\right)\right\}.$$

And, by symmetry, at the point M_2, $V_2 = -V_1$

$$\therefore V_1 - V_2 = 2V_1.$$

Hence

$$V_1 - V_2 = \frac{I\rho}{2\pi a}\left\{1 + 4k\left(\frac{1}{\sqrt{1 + \left(\frac{2h}{a}\right)^2}} - \frac{1}{\sqrt{4 + \left(\frac{2h}{a}\right)^2}}\right)\right\}$$

From the points P_1, P'_1, etc., a further series of images, P_2, P'_2, P_3, P'_3, . . . can be formed by successive reflections in the two separating planes.

Thus P_2 is the reflection of P'_1 in (ρ, ρ')

P'_2	,,	,,	P_2 in (ρ_o, ρ)
P_3	,,	,,	P'_2 in (ρ, ρ')
P'_3	,,	,,	P_3 in (ρ_o, ρ)
.	.	.	.
P_n	,,.	,,	P'_{n-1} in (ρ, ρ')
P'_n	,,	,,	P_n in (ρ_o, ρ)

and similarly for a whole series of images Q_2, Q'_2, ... Q_n, Q'_n . . . At each of the points P_n, P'_n we imagine sources of

magnitude $2k^nI$, and at each of the points Q_n, Q'_n we conceive sinks of magnitude $2k^nI$. Then the potential at M due to such a series, infinite in number, of sources and sinks, is given by the expression

$$V = \frac{I\rho}{2\pi}\left\{\frac{1}{PM} - \frac{1}{QM} + \sum_{n=1}^{\infty} k^n\left(\frac{1}{P_nM} - \frac{1}{Q_nM}\right) + \sum_{n=1}^{\infty} k^n\left(\frac{1}{P'_nM} - \frac{1}{Q'_nM}\right)\right\}$$

and, for the points M_1 and M_2

$$V_1 - V_2 = \frac{I\rho}{2\pi a}\left\{1 + 4\sum_{n=1}^{\infty} k^n\left(\frac{1}{\sqrt{1+\left(\frac{2nh}{a}\right)^2}} - \frac{1}{\sqrt{4+\left(\frac{2nh}{a}\right)^2}}\right)\right\}$$

which we can put

$$V_1 - V_2 = \frac{I\rho}{2\pi a}(1 + 4F), \text{ where}$$

$$F = \sum_{n=1}^{\infty} k^n\left(\frac{1}{\sqrt{1+\left(\frac{2nh}{a}\right)^2}} - \frac{1}{\sqrt{4+\left(\frac{2nh}{a}\right)^2}}\right)$$

and this expression for V, with a suitable expression for the potential V′ in the region ρ', derived from a consideration of the effects due to all the sources and sinks outside the region ρ', satisfies all the conditions necessary in this problem. Moreover, it is the only possible solution for the potential.

Hence, for this case of a non-uniform medium, consisting of two separate media of resistivities ρ and ρ', the former region being bounded by a region of no conductivity, the equation

$$2\pi a\,\frac{V_1 - V_2}{I} = \rho(1 + 4F)$$

is valid.

It is evident that this quantity $\rho(1 + 4F)$, which we may denote by ρ_a, is the so-called "average" resistivity referred to in the Gish-Rooney and subsequent experiments. The term F in the bracket is a function of k, which depends only on the ratio of the two conductivities, and also of $\frac{h}{a}$, which is the ratio of the depth of the surface of separation to the electrode interval. On the other hand, the expression is an infinite series, by no means corresponding to the simple notion of an "average".

The quantity

$$F = \sum_{n=1}^{\infty} k^n\left(\frac{1}{\sqrt{1+\left(\frac{2nh}{a}\right)^2}} - \frac{1}{\sqrt{4+\left(\frac{2nh}{a}\right)^2}}\right)$$

can be evaluated for any desired values of k and $\frac{h}{a}$, and curves can be drawn representing the whole series of corresponding values. Alternatively we may show the variation of the ratio $\frac{\rho_a}{\rho} = 1 + 4F$ with k and $\frac{h}{a}$. This latter is done in Fig. 5, for values $\frac{\rho'}{\rho} = 3$, 4, 9 and 99, corresponding to $k = \frac{1}{2}$, $\frac{3}{5}$, $\frac{4}{5}$ and $\frac{98}{100}$ respectively. In each case the values of $\frac{\rho_a}{\rho}$ are plotted as ordinates against values of $\frac{a}{h}$ as abscissæ. A study of these curves reveals the following characteristics:—

Contrary to the Gish-Rooney hypothesis there is no abrupt change in the curves when $a = h$, i.e. the electrode separation interval is equal to the depth of the subsurface separating the media ρ and ρ'. The value of ρ_a begins to deviate from the value of ρ, the specific resistivity of the upper layer, before $a = h$, so that the effect of the greater resistivity of the lower layer ρ' makes itself evident for electrode separations less than the depth of its upper surface. For values of a, which are large compared with h, the value of ρ_a approaches a limit equal to ρ', so that the full effect of the lower layer is only experienced at very large electrode separations. If ρ' is very large compared with ρ, the value of $\frac{\rho_a}{\rho}$ when $h = a$ is very nearly 1·5. This can be seen on the $\rho' = 99\rho$ curve in the figure; and for any greater ratio of $\frac{\rho'}{\rho}$ the curve in this neighbourhood is very nearly the same. As the specific resistivity of the ordinary overburden is generally much lower than that of the rock below it, a valuable indication

of the depth of the rock at any point can frequently be obtained from the above relationship.

It will be seen that all the curves have two portions of maximum curvature, one "upwards" and the other "downwards". The former occurs for the value $a = \frac{h}{2}$ approximately, and the latter for values of from $a = 2h$ to higher values, according to the magnitude of the ratio $\frac{\rho'}{\rho}$. Between these two points of greatest curvature there is a point of inflexion, where the curvature changes from "upward" to "downward". This occurs at about the point $a = \frac{3}{2}h$. Provided this point of inflexion can be recognized fairly clearly, a fair determination of h can be effected by a careful study of the curve for various increasing values of a.

From the above considerations, it is quite evident that even for the simple case here considered, where there are only two media in question—an upper one of resistivity ρ and a lower one of resistivity ρ', besides the air above the ground surface—the determination of the depth h from a study of a single "average" resistivity curve, obtained by a series of measurements at increasing electrode spacings, is nothing like so simple as on the Gish-Rooney hypothesis of an abrupt change when $a = h$. By a careful analysis of the curve with reference to its points of maximum and minimum curvature, and other characteristics, a reliable estimate can be made. Such an estimate will become very uncertain if other disturbing influences are at work, for example, if the upper medium has a non-uniform character.

Instead of studying the behaviour of the "average" resistivity ρ_a, we can study that of its reciprocal, the "average" conductivity

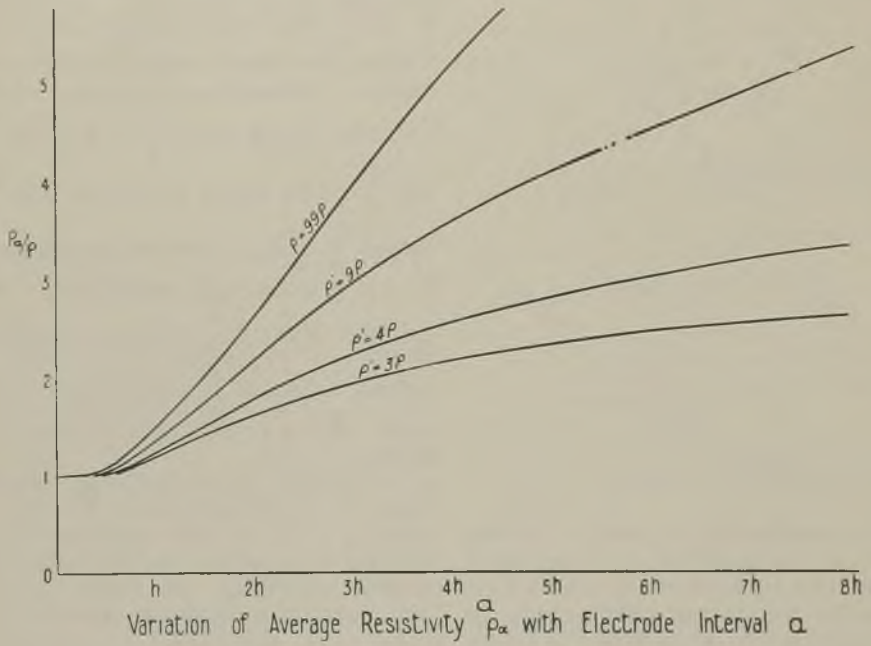


FIG. 5.

σ_a, which is obtained by the simple relation

$$\sigma_a = \frac{1}{\rho_a} = \frac{\sigma}{1 + 4F}; \text{ where } \sigma = \frac{1}{\rho}.$$

In Fig. 6, three curves have been plotted. These were made to suit a particular problem, but they can be regarded as characteristic. Two of them show the variation of the quantity $\frac{\sigma_a}{\sigma}$ corresponding to two ratios $\rho' = 9\rho$ and $\rho' = 99\rho$. The abscissæ in these curves are shown as the depth h of the lower medium ρ' below surface in actual feet, but the curves would be exactly the same if the abscissæ unit 40 were taken as the interval a, and all other values in proportion. Thus 80 would become $2a$, 100 $2{\cdot}5a$ and so on. The curves would then

represent the variation of $\frac{\sigma_a}{\sigma}$ as ordinates against values of the ratio $\frac{h}{a}$ as abscissæ. For any value of $\frac{\rho'}{\rho}$ between 9 and 99 the curve would lie between the two shown, whilst for values greater than 99 it would practically coincide with that for the ratio 99. The curves show how the ratio $\frac{\sigma_a}{\sigma}$ varies for a fixed electrode separation a when the depth of the lower layer h varies. In other words they indicate to what extent we may expect to get indications of varying depth of this layer as we make a traverse or area survey at a fixed electrode spacing interval.

One fact stands out in considering these curves, namely, the straight-line, or uniform slope character of the curve for all values of h up to about $h = a$. For such depths, the quantity $\frac{\sigma_a}{\sigma}$ is almost directly proportional to the depth. This is a very valuable feature. It expresses the fact that, provided we are surveying an area where there is a uniform upper layer so that we can assume σ_a is proportional to $\frac{\sigma_a}{\sigma}$, the varying depth of the underlying surface separating the upper from a more highly resisting lower layer can be mapped out simply by noting the values of σ_a and regarding these as directly proportional to h. Since the straight line or direct-proportion character only holds when h is less than a, a value for a should be selected which exceeds the most probable value of h in the area.

The method is thus clear for a very rapid area survey, if the object is merely to delineate sub-surface structure. A single electrode spacing interval is chosen of magnitude sufficient to ensure that it is greater than all likely values of h in the area, but not so great that fluctuations in h are no longer appreciably represented by fluctuations in σ_a, and the values of the latter measured at a series of points throughout the area forming a network. All points having the same value of σ_a are joined by "lines of equal average conductivity." Such lines may then be regarded as sub-surface layer contour lines, and a single determination of the depth h at any one point will suffice to fix the depth at any other. One obstacle, however, cannot be ignored. It is assumed in the above that the resistivity, or its reciprocal the conductivity, of the upper medium σ is constant throughout the area surveyed. As a precaution to test this, it is desirable to run a series of supplementary measurements at a second electrode spacing (smaller than the one previously selected), which will indicate the more pronounced fluctuations in σ. Where such are encountered, it will be necessary to correct the former values of σ_a for these fluctuations, and it may even be necessary at such points

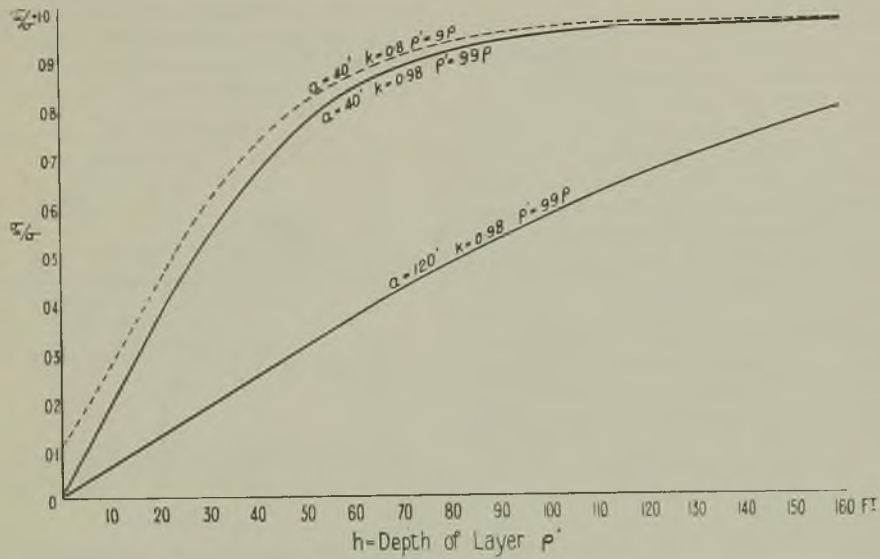


Fig. 6.—Diagram showing Variation of Conductivity with Depth of Highly Resistive Bed.

to take a full series of measurements at gradually increasing electrode intervals.

TEST SURVEY IN CUMBERLAND.—An interesting test of the earth-resistivity method has recently been afforded to the author by the courtesy of the Hodbarrow Mining Company, Ltd., who placed at his disposal a selected portion of their area, and provided all the necessary labour and equipment with the exception of the Megger Earth Tester. The latter instrument was lent by the makers, Messrs. Evershed and Vignoles, Ltd., of Chiswick, and will be more fully described shortly. Briefly, it combines in a single compact instrument the Gish-Rooney apparatus.

The region surveyed, known as the Red Hill area, is shown on the accompanying plans, Figs. 8 and 9, and extends about one-third of a mile in the direction NW–SE, and about one-quarter of a mile in the direction NE–SW. Numerous borings, shown on the plan, have served to reveal the sub-surface structure with a high degree of detail. Primarily the region comprises an uplift of carboniferous limestone overlain by glacial drift and underlain by conglomerate beds. On the NW and SE flanks, the limestone has been much eroded, and finally disappears entirely. This is shown in section 1 of Fig. 10. From NE to SW, however, the limestone is fairly thick, and averages about 50 feet below the ground surface. It outcrops in the region of Red Hill Farm, and forms a massive mound, now largely excavated at Red Hill Quarry. Here also it comes very near to the ground surface. Except in the quarry neighbourhood, and in a very small area at the farm, the surface topography is very flat.

The primary object of the survey was to test the application of the method to the detection of hematite iron ore, which occurs in the central portion of the area (see Fig. 9 sections). Laboratory tests had shown, however, that the resistivity of the ore was not very different from that of the country rock, limestone, so that no great hope of effecting this primary objective existed. A secondary objective was to test the possibility of mapping out sub-drift topography by this method, with the particular view of utilizing the method as an auxiliary to gravitational surveys with the torsion balance. Prior to outlining the details of the survey, it will be convenient to describe the construction and operation of the Megger Earth Tester.

THE MEGGER EARTH TESTER.—The Megger Earth Tester, illustrated in Fig. 1, was originally intended for the measurement of the resistances of earth plates, etc., and has been adapted to meet the special requirements of geophysical surveying by means of earth resistivity determinations. A diagrammatic representation of the system of components and connexions is shown in Fig. 7. The source of current supply is a small hand-driven direct current generator, and the measuring instrument is a moving coil ohmmeter. Two synchronous commutators are mounted on the same shaft as the generator, and the ohmmeter embodies two coils mounted at a fixed angle to each other on a common axle which is pivoted in the field of a permanent magnet. The axle carries a pointer which moves across a scale graduated directly on ohms. The

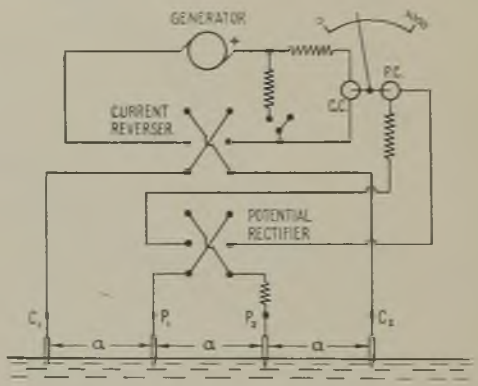


FIG. 7.

current through one coil (the current coil) of the ohmmeter is a definite fraction of the total current flowing between the terminals marked C_1, C_2, which are connected in use to the outer pair of electrodes ; the other coil carries a current definitely proportional to the potential difference between the terminals P_1, P_2, which are connected to the inner pair of electrodes. By means of suitable shunts and resistances the currents can be adapted to meet varying conditions, so that the meter can register four different ranges, viz. 0–3, 30, 300 and 3,000 ohms. respectively. For actual ground resistances the first range is normally the most convenient in practice, whilst for determining the resistances of the electrodes themselves, the third range is most generally useful. The current and potential coils of the meter are wound so as to be in opposition, so that the needle moves in proportion to the ratio of the potential drop V_1–V_2 to the current I, and records in

effect this ratio $R = \frac{V_1 - V_2}{I}$. The commutators serve to convert the direct current into alternating prior to its entry into the external circuit and to rectify the picked up alternating "potential" current before it proceeds to the coil of the meter. The readings are independent of the generator voltage, and become steady after the handle has been rotated for a few seconds. The instrument is usually rested on some firmly bedded portable stand, to permit steady, uniform rotation of the generator spindle. The complete outfit is readily transported and exceedingly simple and reliable in operation. Further reference may be made to an account by Dr. W. F. Lee of measurements with a "Megger" described in the United States Bureau of Mines Technical Paper No. 440 and to the descriptive pamphlet issued by the makers.

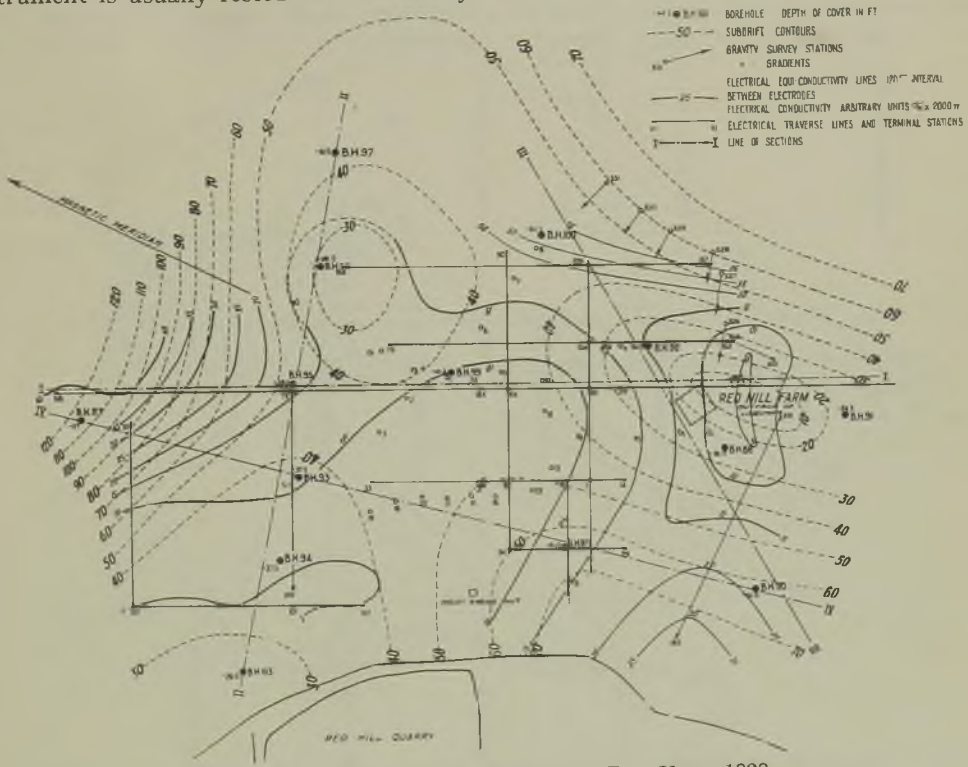


FIG. 8.—MEGGER ELECTRICAL SURVEY, RED HILL, 1929.

DETAILS OF THE TEST SURVEY IN CUMBERLAND.—As a preliminary test of the variation of the measured resistance R with increasing electrode spacings, measurements were made at each of the stations in the neighbourhood of B.H. 89 (see Fig. 8) with electrode intervals of 20, 40, 60, 80, 100 and 120 ft. By multiplying each R by the corresponding value a, values are obtained which are proportional to the "average" resistance. For homogenous ground of uniform resistivity ρ, each of these values should be the same. For ground in which a second layer of resistivity ρ' is encountered at a depth h, the average resistivity should follow the variation of the corresponding curve $\frac{\rho_a}{\rho}$ in the theoretical case represented in Fig. 4. According to the borehole log of B.H. 89, limestone should be penetrated at a depth of about 60 ft., and ore at depths of from 115 to 125 ft. (see Section IV, Fig. 10). The actual variations of the products Ra are shown in the three continuous line curves of Fig. 10. A careful comparison of these with the theoretical curves for $\rho' = 99\rho$ and $\rho' = 9\rho$ (shown dotted in Fig. 11) show that they correspond to the case in which at a depth of approximately 40 ft. below the surface, a layer of resistivity of about 30 times that of the drift is encountered. Assuming the values

$\rho = 2\pi \times 20$ ohms. $\times$ feet,
$\rho' = 2\pi \times 600$,,
$h = 40$ feet,

the theoretical curve would correspond closely to the observed ones. Subsequent tests on limestone outcrop have given a much higher value, namely about $2\pi \times 2{,}500$ ohms × feet, than the one assumed here for ρ', but the value of $2\pi \times 20$ for the drift resistivity is well established on the average for this area.

The conclusion drawn from measurements at these three stations is therefore that the penetration of some intervening layer, at about 40 ft. depth, has obscured the evidence of the actual penetration of the limestone, taken at a single, or in most cases only two, electrode spacings. For the most part, the spacings used were 40 and 120 ft., but the series for the latter interval is more complete than the former. It was felt that an interval of 120 ft. would be sufficiently large to give evidence of the penetration of the rock, which hardly anywhere is at a greater depth below the surface than 120 ft., whilst the 40 ft. measurements would more faithfully record the variations in the uniformity of the actual drift. From these measurements, which in each case gave the

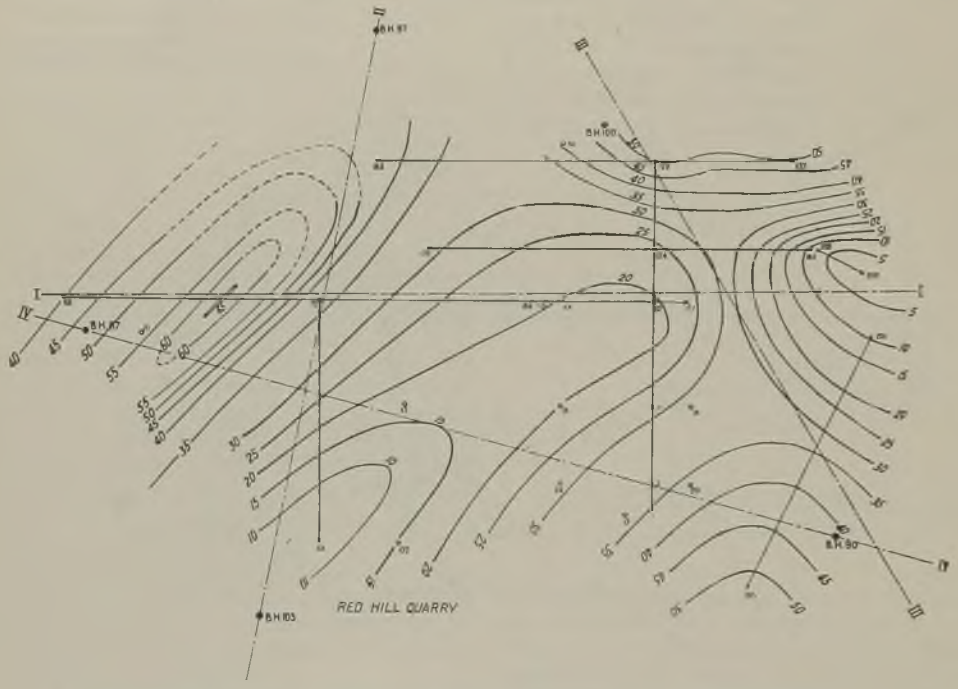


Fig. 9.—Megger Electrical Survey, Red Hill, 1929. Lines of equi-conductivity, 40 ft. Interval. Arbitrary Units, $\cdot\ \sigma_a \times 2{,}000\pi$.

which, according to the borehole log, should occur at a depth of 60 ft. The curves give no evidence of any irregularity due to the penetration of hematite ore in this region, although the ore is well established both by boring and mining operations, and is, in fact, more extensive than the borehole would suggest. The result of these preliminary measurements, therefore, whilst very interesting, could only be regarded as inconclusive, and indicative of the obstacles to the practical application of the simple theory of the method.

In the next series of measurements, a different procedure was adopted. At each of some 200 stations, measurements were

value R, the values $\frac{1{,}000}{Ra}$ were calculated and tabulated.

Assuming that $\rho_a = 2\pi a\mathrm{R}$

$$\sigma_a = \frac{1}{\rho_a} = \frac{1}{2\pi_a \mathrm{R}},$$

$$\therefore\ 2{,}000\pi \times \sigma_a = \frac{1{,}000}{Ra}.$$

Hence the values tabulated are proportional to the "average" conductivity for the particular electrode separation. Points of equal conductivity were joined up by continuous lines, and are shown by means of such lines in Figs. 8 and 9. In the former figure, the sub-drift contour lines as derived from

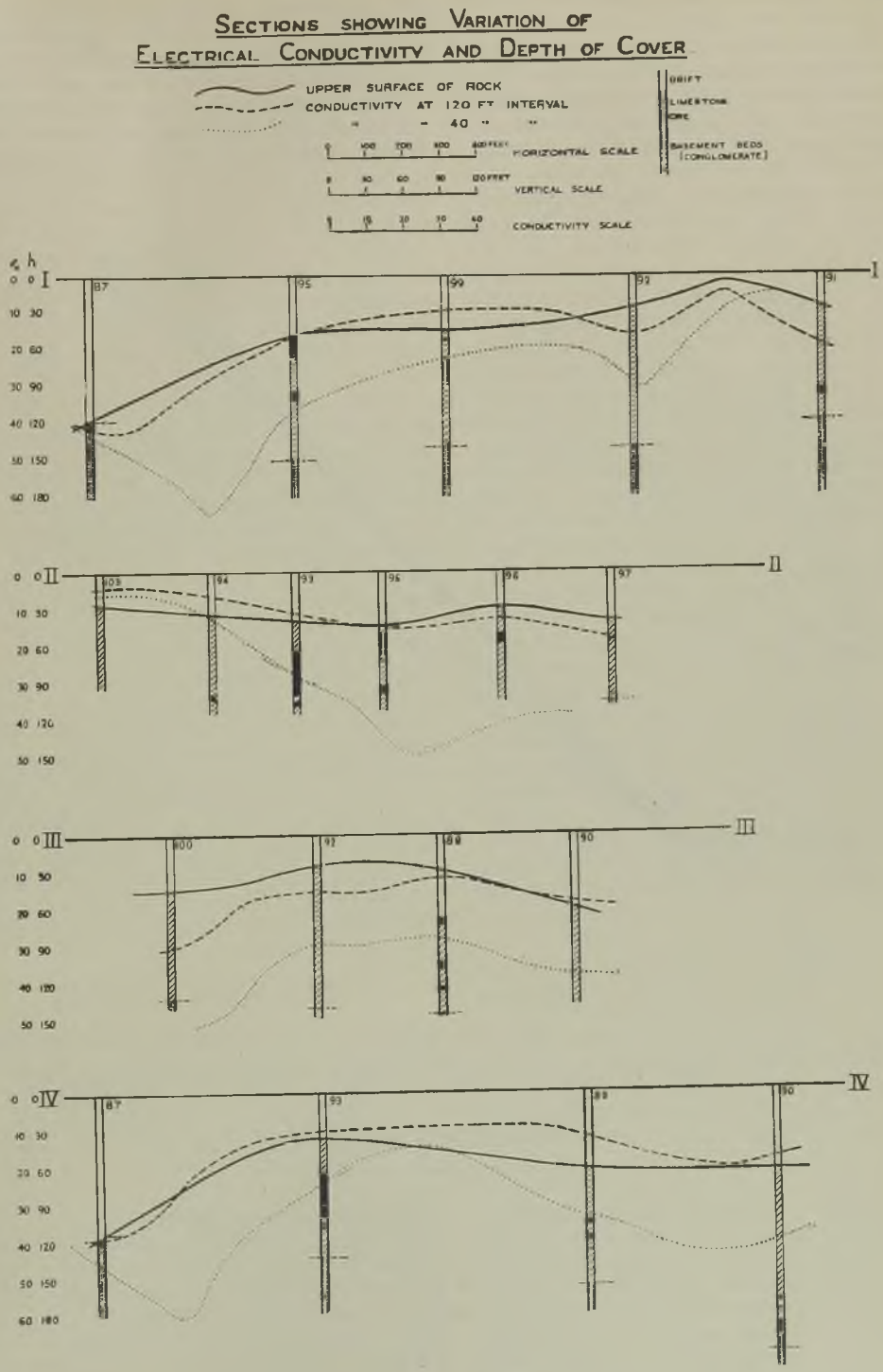

SECTIONS SHOWING VARIATION OF
ELECTRICAL CONDUCTIVITY AND DEPTH OF COVER
UPPER SURFACE OF ROCK
CONDUCTIVITY AT 120 FT INTERVAL
" " 40 " "
DRIFT
LIMESTONE
ORE
BASEMENT BEDS (CONGLOMERATE)
HORIZONTAL SCALE
VERTICAL SCALE
CONDUCTIVITY SCALE
I
II
III
IV

FIG. 10.

borehole data are also shown by hatched lines.

A careful study of Fig. 8 shows that the lines of equal average conductivity at 120 ft. electrode interval bear a striking similarity in grouping and shape to the sub-drift contour lines. A region of low conductivity corresponds to a region of small thickness of " cover " and vice versa. The two pronounced limestone uplifts at the quarry and Red Hill Farm are quite well outlined as regions of especially low conductivity. These two features are equally prominent in Fig. 9, as the electrode spacing of 40 ft. in this series is well beyond the thickness of the cover in these two areas. Similarly the secondary limestone " knoll " in the neighbourhood of B.H. 96 is to some extent indicated in the electrical conductivity lines by a minor deformation of the " 15 " line.

The downfall of the limestone from these high regions on the flanks of the area to the NNW, SSE and SSW is particularly paralleled by the conductivity lines. The " declivity " to the NE of Red Hill Farm is especially worthy of mention, in that it was not suspected prior to the Megger Earth Tester survey, as no borings existed in this flank. Subsequent to the indications of the " Megger " survey, however, this declivity has been confirmed both by a gravity survey with the torsion balance and by a boring

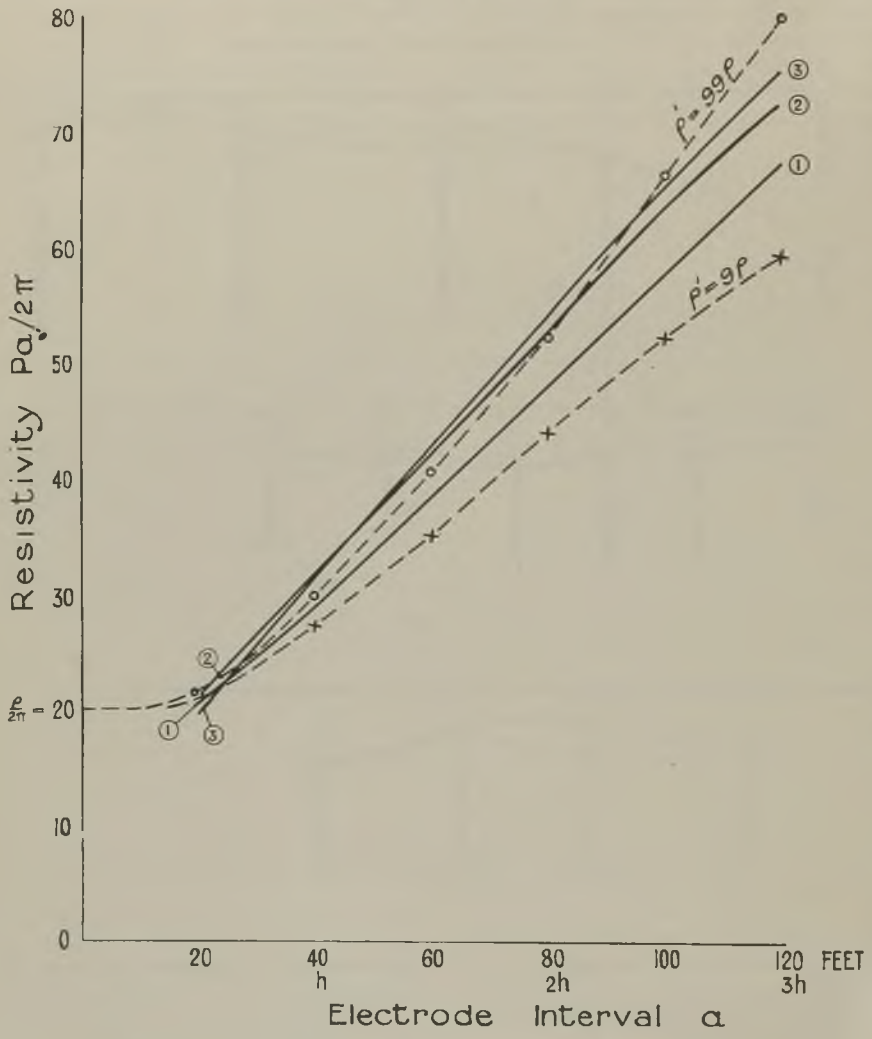


Fig. 11.

(not shown on map). A few gradients of the gravity survey are shown in Fig. 8 and it is readily apparent how precisely they confirm the existence of this limestone "slope."

In Fig. 10, sections across the area on the four marked lines are illustrated, and the comparison between the conductivity curves and the section of the drift-limestone surface is seen to be very instructive and reasonably close. Moreover, where the discrepancies are most pronounced, e.g. B.H. 100 on Section III, and B.H. 89 on Section IV, a study of the curve given by the measurements at 40 ft. electrode spacing shows that the most probable explanation is a lack of uniformity in the nature of the "cover." It may be concluded, therefore, that the lines of equal average conductivity at 120 ft. interval would very closely correspond to sub-drift contours were there not difficulties due to the lack of uniformity of the cover. Even in spite of these obstacles, the survey on this basis gives a strikingly accurate picture of the sub-drift features, both qualitatively and quantitatively. There is little evidence that the hematite occurrences can be indicated and located by this method. Any fluctuations which might arise from the penetration of these ore-bodies are practically completely obscured by the more pronounced variations arising from the undulations in the sub-drift surface and the lack of uniformity in the cover.

The total time spent in the field during this survey was about a month, and the personnel varied from three to four. With a party of six, divided into two sets, one laying out electrode pins and locating the survey lines, etc., and the other making connexions to the instrument and taking measurements, a considerable saving in time would be possible, and a survey of this extent and character might well be accomplished in a little more than a week's field work.

Conclusion.—The test has shown that the more elaborate theory of earth-resistivity previously described is necessary to represent correctly the phenomena which occur in practical exploration. Even with this expansion in the theory, the observed data require careful and critical analysis if correct interpretations are to be obtained. Whilst it will generally be desirable to make a series of measurements at several electrode spacing intervals at each of a series of selected critical stations, a very valuable preliminary reconnaissance over the whole area can be obtained using only a single spacing interval, carefully chosen with reference to the most probable depth of the surface of which it is sought to map the features.

For mapping sub-drift or similar features, the method would appear to be very economical and promising, but further tests of typical regions are desirable to establish the correct principles of procedure and interpretation.

In conclusion, the writer would express his grateful appreciation of the generous assistance afforded by the Hodbarrow Mining Company, Ltd., and Messrs. Eversheds and Vignoles, Ltd., in the supply of equipment and personnel, and for the permission to publish in full detail the account of this test of a geophysical method which holds much promise.

BOOK REVIEWS

Les Méthodes Géophysiques de Prospection Appliquées à la Recherche du Pétrole. By G. A. Boutry. Paper covers, 172 pp., illustrated. Price 20 francs. Paris: La Revue Pétrolifère.

This book will doubtless appeal to the layman who desires to acquaint himself with the rudiments of applied geophysics, as it gives a clear and unbiassed account of the four principal methods employed, dealing with the theoretical principles, field instruments, and also giving examples of their application in the field. It is not intended as a contribution to the advancement of the subject; its purpose being purely to draw attention to the various ways in which the science of applied geophysics can be of assistance in prospecting for oil.

In the introductory chapter the author discusses the various hypotheses concerning the origin of petroleum, and the increasing difficulties encountered in prospecting for oil. He considers the principal oil-bearing regions of the world, and indicates the most important structures favourable to its occurrence, pointing out the inefficacy of geological prospecting under certain conditions and the increasing usefulness of geophysical methods. This introduction is followed by four chapters dealing respectively with the gravitational, magnetic, electrical, and seismic methods, the object of which is to show that these methods can be applied to problems connected with the location of salt-domes, monoclines, anticlines, etc., which

are favourable to the occurrence of oil. In each chapter a concise elementary theoretical exposition of the method is followed by a description of the principal field instruments employed and their manipulation, after which practical examples are in some cases given. The book concludes with a bibliography of a number of publications which have been recently added to the now extensive literature on this subject.

H. Shaw.

Les Méthodes Géophysiques pour L'étude Couches Superficielles du Sol. By Ch. Maurain. Paper covers, 29 pp., illustrated. Price 10 francs. Paris: La Revue Pétrolifière.

This small publication is a reprint of two articles which appeared in *La Revue Pétrolifière* No. 322 on May 25, and No. 323 on June 1, 1929, in which the author considers the geophysical methods of prospecting generally, and their application to geology. He expresses the view that they are of value for investigating the upper layers of the earth's crust, both from scientific and practical standpoints, and that with the development of the theory and practice of the methods their usefulness will continue to increase.

As a résumé of the subject, it is both clear and interesting but makes no contribution to the development of the science of Applied Geophysics. A useful list of references is appended.

H. Shaw.

☞ 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.

LETTERS to the EDITOR

The Future of the Rand

Sir,—I have read with great interest the matter under the heading of "Rand's Low-grade Ore Problem" in your Johannesburg news letter in the May issue of your magazine. I am glad that Sir Robert Kotze has called attention in the Union Parliament to the advisability of a committee being appointed to inquire into the question of working the low grade ore of the Rand.

He stated that there were 440 million tons of ore containing between 3½ and 4½ dwts. of gold per ton lying fallow; that if the working costs could be reduced by a 1s. a ton a further 3½ million tons of ore could be worked annually, with the employment of 20,000 white people and 100,000 natives; that the State would derive an additional £400,000 a year and the railways and harbours a little more; and that if the costs could be reduced by 2s. a ton these figures would be doubled. The figures for employment and Government revenue evidently also include those due to the indirect results which would be obtained.

The Union Government appointed an Economic Commission in 1913 and a report was prepared for it by the Transvaal Chamber of Mines on the Life of the Rand Gold Deposits, which was completed in December of that year. To illustrate the importance of lower working costs it pointed out that, milling 28 million tons yearly, a reduction of 1s. per ton in costs meant an increase of £1,400,000 in profits.

The publication of this report exercised a depressing effect at the time on public opinion. Results have proved better than its forecast, especially as the areas on which its estimates were based did not include 96,560 claims on the Eastern, and Far Eastern, Rand which it was admitted contained "hundreds of millions of tons of ore," nor did the areas on the Far South-Western Rand, to the south of Randfontein, figure in the calculations. Later, in July 1922, the Transvaal Chamber of Mines presented to the Mining Industry Commission remarkable data showing that with the average working costs for 1921, namely 25 shillings and 8 pence per ton, the payable ore on the Rand was 316 million tons; but, that if costs could be reduced to 13 shillings per ton a further 724 million tons could be profitably mined.

As long ago as 1917,[1] I pointed out that the Rand was each year developing, more and more, into an enormous, well-managed, low-grade gold field; and that with less water as depth increases, greater attention to ventilation, increasing tonnages milled, closer supervision, greater underground efficiency and, consequently steadily decreasing costs, its life was being lengthened by the continuous inclusion of lower grade ore within the economic limit. Further, having regard to this fact, I pointed out that the total gold recovery from the Rand could with confidence be put, as a minimum, at between 1,000 millions and 1,300 millions sterling.

1 "The Gold Deposits of The Rand" by C. Baring Horwood. (Chas. Griffin & Co., London.)

I pointed out that at most mines on the Rand the pay-limit was put at the low figure of about 4¼ dwts., but that some mines were even then working ore below this value at a profit, and that there were millions of tons of low grade Main Reef alone (quite apart from the other reefs) varying from 3 to 4½ or 5 dwts., much of which it would some day pay to mine.

Since then this prophesy has gradually been coming true, and the average pay-limit of the ore that can, on a large scale be profitably mined and milled has still not been reached.

C. Baring Horwood.

Abbey House, Victoria St.,
S.W. 1.
June 26.

The Education of the Engineer

Sir,—Your articles and letters on the above subject in the April, May, and June issues have I know been read with deep interest by Associates of the Royal School of Mines. Many of us had become aware of the situation to which Mr. Agnew calls attention, and some I fear are almost prepared to agree with him in his diagnosis of the complaint.

I do not believe that any school of mines, be it American or Continental, can turn out mining engineers—the Royal School never professed to do so, the word engineer or engineering did not even occur in its syllabus. The Royal School can, I imagine, turn out as sound technically-trained mining students as any of the other schools. It is, however, as Mr. Agnew says, the atmosphere in which this training is obtained, coupled with the suitability of the first few years of practical work, which determine whether the necessary metamorphosis from the mining student to the mining engineer has been satisfactorily accomplished. The best mining student may never make a mining engineer. I believe the weakness of the Royal School lies largely in the failure to obtain the right type of student. Many students enter the Royal School of Mines without the remotest idea of what a mining engineer's job really is. To them it is a technical college with a nice name and a famous record, and follows on conveniently after a rather "padded" educational course at one of our modern schools. Mining Engineering was, and is, a man's job. I believe there are no women in it yet, though I can almost imagine that young women of the order of Miss Amy Johnson might supply the type of student required.

The superiority complex of the R.S.M. student noted by Mr. Agnew, and approved by Mr. Tizard, is interesting, and I rather like it, though it certainly would not have "cut much ice" in the days when Cornish and Welsh mine managers and mine captains were the officials the graduate student had to deal with.

Would not the requirement of a sound knowledge and efficiency in some of the more practical subjects, such as mechanical engineering and book-keeping and accountancy, sacrificing, say, the more advanced study of geological subjects, leaving these as they deserve to the specialist, tend to create an atmosphere in the School more in keeping with realities? A lack of mechanical knowledge amongst mining men has accounted for more mistakes and failures than has a lack of advanced geological training. A metallurgist and a chemist are both far better men if they possess sound mechanical instincts.

The old school was, perhaps, wise when it refused to include the word engineer in its syllabus, but to-day the miner or the metallurgist who calls himself an engineer must have sound mechanical knowledge and be able to use both his hands and his head. Are the men who are going to design and run the metallurgical plants of the great copper industry growing up before our eyes in N. Rhodesia being trained at the Royal School of Mines?

Ernest R. Woakes.

Stevenage, Herts.
June 26.

Sir,—The correspondence concerning the education of the engineer that has appeared in the Magazine must be of interest to all young engineers who have recently qualified. Coming under this classification myself I venture, therefore, to offer my views on the subject. The whole essence of the matter, in my opinion, is whether the object of such institutions as the Royal School of Mines is to train their men to be merely miners or whether they have the distinct purpose in view of their students eventually becoming mine managers. I have been led to believe that the latter is their policy. If, therefore, a R.S.M. man has in view the attainment of a manager's position, for his underground experience alone he must, according to Dr. Horwood's

scheme, rise through the stages of sampler, shift boss, foreman, underground manager, and assistant manager.

Under this system the graduate coming fresh from his "splendid education" is frequently expected to exercise his abilities in a relatively limited sphere of action, as a sampler or surveyor for several years, during which period his general mining knowledge gets blunted and out-of-date, whilst often he is under the orders of a man whose mining education is thirty years behind the times. The result, I maintain, is unsatisfactory both to the man and to the company for whom he is working. I would suggest that this system is intrinsically unsound and uneconomic and I would put forward the following as an alternative which would work well and pay both the employer and the employee :

Graduates of such schools as the R.S.M. should be given directly a post as assistant engineer to the manager. In this capacity he can gain his experience from all departments as occasion arises ; he can relieve the manager of an immense amount of the "spade work" of management, thus releasing him for other matters of greater import ; he can learn to deal with men of all the different types that go to make up the labour force of a mine ; he is learning management first-hand and not indirectly, and he can bear just as much responsibility as his chief, the manager, finds him capable or worthy of bearing. In addition the company has the assurance of knowing that right there on the property they have a man ready to assume the reins of management in the event of death or illness removing the manager. There will be no interregnum whilst a new man is sent out and gets to know the property. In the course of, say, ten years that man would be eminently fitted for management. One can hardly say the same for the man whose sole experience for a similar period has been gained underground.

It is also to be considered whether it is right that positions such as shift boss or foreman should be occupied by the graduate type of man. Surely these positions should be occupied by those working miners who, by their experience and enterprise, have worked their way up from the ordinary class of miner and shown themselves to be fit for more responsible positions.

The management of mines should be in the hands of men trained from their youth to manage all the departments which come under their general supervision as manager, and I contend that the R.S.M. man is most effectively trained for this purpose. At present, however, the industry is not ready to use such men properly. The need for reform and improvement is in the industry and not in the system of education. Many British companies foolishly economize on the administration side of their staffs, because, perhaps, such expenditure can rarely be offset directly by a reduction of costs per ton. There must be many cases where a manager would be enabled to reduce his working costs had he the assistance of a young engineer to help him.

Mr. Tizard's letter is to be welcomed as an indication that some mining companies at least are gradually waking up to the need for utilizing the material provided for them by the many excellent schools of mines that the Empire possesses.

LEONARD G. BROWN.
103, Lower Road,
S.E. 16.

NEWS LETTERS

JOHANNESBURG

June 5.

The Prospecting Concession in S. Rhodesia.—Further details are now available with regard to the new concession in Southern Rhodesia. The area to be prospected is, roughly, the south-eastern corner of the colony. It extends from the intersection of latitude 20° and longitude 31°, down the latter meridian to the Lundi River, thence down that river to the Portuguese border ; thence north along the border to latitude 20° and thence along that parallel to the starting point. The area is for the most part a long distance from the railway and very hilly in the parts where mineral discoveries are most likely to be made. Fort Victoria is about 20 miles from the north-west corner of the area, and Umtali 70 miles by road from the north-east corner. These are the nearest points. Previous mining activities in the area have been small tinfields, copper at Umkondo, coalfields at Malilanga (between the Cheredsi and Sabi rivers) and copper between Cheredsi and Mtilikwe. Gold has been washed in the Cheredsi River, but the original source has not yet been found. The most likely developments will be copper, coal, and gold in the central portion of the area, 80 to 120 miles from the railway at Fort Victoria.

Life of Gold Mining Industry.—The Acting Minister of Mines (Mr. O. Pirow) made an interesting statement in Parliament recently regarding the life of the gold mining industry. He was asked by one of the Johannesburg members to say whether the estimate made by the Government Mining Engineer some years ago, that the value of the remaining gold on the Witwatersrand and in other gold mining areas in South Africa was approximately £100,000,000, appeared in need of revision in the light of more recent information. The Acting Minister replied that recent developments did not show that the Government Mining Engineer had been unduly optimistic. No new geological information was available, but certain new features had been disclosed from the working of new mines. The East Geduld had justified the opinion that a large gold mine would come into working in that area, while the Daggafontein Mine had restarted work with fairly satisfactory results. The Modder East had gone in for much development work, and the directors were satisfied that the mine had very great possibilities. The Government Mining Engineer's expectations of other East Rand Mines had been just about fulfilled.

Tenders for Lease Area Claims.—Apparently none of the big mining houses want any of the 1,500 claims on the farm Vogelstruisfontein No. 62 which have been offered by the Government as mining lease areas. Three tenders for portions of the area offered have been received from William Henry Pring, the Vogel Dump Syndicate (A. P. Woollwright and S. S. Scott), and the Minerals Recovery (Proprietary), Ltd. These tenders do not involve an area of more than some half a dozen claims. For the bulk of the area of 1,500 claims, comprising the old Bantjes and Vogel Deep ground no offer has been made. On the eastern side, the lease area is bounded by the property of the Consolidated Main Reef Mines and Estates and the old Aurora West, while on its western edge it adjoins various claim areas registered in the names of the New Steyn Estate, Roodepoort United Main Reef, and others.

Northern Rhodesian Coal.—According to recent advices from Northern Rhodesia, the Hot Springs coal-bearing area is still being tested by the Tanganyika Concessions. The Loangwa Concessions and the Bailey Group are also interested, both owning considerable areas on the coalfield. The question of the calorific value of the coal is still unsettled, and, should that be decided in favour of the product of the new field, there will, of course, remain the big difficulty of transport. Hot Springs is over a hundred miles due east of Broken Hill, and about two hundred miles south of Kansanshi. The latter will doubtless in course of time be linked up with the Angola railway, which will mean opening up a big market for the new coalfield should the coal be satisfactory.

South African Mining Engineers.—According to a cablegram published in the Southern African Press, Professor K. N. Moss, Professor of Mining at Birmingham, on returning to England from the Empire Mining and Metallurgical Congress, deplored the fact that mines in Rhodesia and the Union are unable to obtain enough trained British engineers. This position is unfortunately true of the Rand, but it is not likely to be perpetuated. A few years ago the Witwatersrand University had only two student engineers; today, thanks to the improved conditions in the mines, there are 60. An outstanding feature of their training is the scheme instituted by the Chamber of Mines under which students spend their fourth year underground and come to the University only two days a week.

BRISBANE

May 15.

Australian Mining.—The great slump that has lately taken place in the market prices of both tin and copper, coupled with the downward tendency of silver, lead, and zinc, is having a serious effect on the mining industry of Queensland. Up to the end of March, the output of copper and tin was improving, but it is certain that both April and May will record a marked decline. Already one of the best operative copper mines in the Cloncurry district has closed down, while a number of copper gougers have abandoned their "shows." Miners in the Herberton district also, Queensland's chief tinfield, are ceasing work and concerns that were preparing to launch out in fresh mining enterprises, both in tin and copper, are holding their hands. The Girofla mine, at Mungana, which has been one of the chief supplies of ore to the recently reopened State Chillagoe smelters and which has of late been worked by a syndicate, is closing

down, probably permanently, owing to the low price of lead. Of course, the restrictive element operating in Queensland affects the other Australian States, and the previously threatened closure of some of the Broken Hill mines will no doubt be hastened. Mount Lyell is still the only big company producing copper in Australia, if the small quantity precipitated from Mount Morgan mine waters is excepted, but so severe is the drop in copper, that even this corporation must feel the pinch, notwithstanding the fact that it has other subsidiary productions to help.

The Whitworth Company.—It is now definitely stated that the London corporation, the Whitworth Mining and Finance Company, stopped operations in the Herberton district, North Queensland, at the end of March and paid off its employees. It's last work was on a mine called Wyatt's lease, at Irvinebank, over which the company held an option. 952 tons of ore was raised in that month, and gave only an estimated return of 1% of tin. The last crushing from the mine consisted of 1,028 tons of ore, which yielded 7 tons of tin, valued at £627. It is considered that the low value of the ore, combined with the falling price of tin, led to the cessation of operations. The company previously held the Vulcan, one of the oldest and for years one of the best tin mines of the State, but after working it for some time let the property on tribute to a party of miners, who in February gave up the mine.

Mount Isa Progress.—The Inspector of Mines at Cloncurry, in his report for March, states that the water difficulty in the Mount Isa mines is not getting easier, and lately has been giving considerable trouble. In the cross-cut in the man and supply shaft, which had then been driven 70 ft. east, progress, he says, was being much hampered through excessive water. The flow here increased to 22,000 gallons an hour, and two electric pumps were installed to cope with it. A temporary stoppage in the sinking of the main haulage shaft was due also to increased water, and a larger pump has here likewise been installed. Pumping is being continued at Lawlor's shaft, on the Rio Grande lode. The air shaft (46) has been concreted down to 254 ft. from the surface ; and at Doherty's on the Black Rock lode, the 300 ft. level roadway for ore haulage has been dealt with. The drives and cross-cuts in the grizzly and haulage levels on the Black Star lode were extended in March for an aggregate distance of 366 ft. The Urquhart (man haulage) shaft was down to 479 ft. and good progress was being made in the construction of the mill, smelter, and power house. In four weeks 740 ft. of diamond drilling was done on the Black Star lode. The water pipe-line between Rifle Creek and Mount Isa was at this time laid a distance of 16 miles, leaving a length of four miles to be put down.

Promising Gold Discovery.—The Federal and State Governments are to be asked by a small syndicate to assist an expedition into the heart of Australia in search of a gold reef said to be from ten to twelve miles long and 10 ft. wide, that assays on an average 3 oz. to the ton. The reef is affirmed to have been discovered many years ago by a man (H. B. Lasseter) who had set out from Townsville, North Queensland, to cross the continent alone. Later he returned to the locality with a Western Australian miner, who, after a careful survey, declared the lode to be richer and bigger than the Golden Mile at Kalgoorlie. It is, however, greatly handicapped through want of water, the nearest supply being many miles away.

Queensland's Mineral Output.—The final official returns of the Queensland Mines Department show that the total value of the mineral output of this State for 1929 was £1,707,179, which is an increase of £320,260 compared with that of the previous year. This result was achieved in spite of the fact that in the output of both tin and gold there was a considerable decline. In each of the preceding four years there had been a decrease in the total output. For a number of years past coal has taken the place of gold as the chief mineral product of the State.

Oil Prospecting.—Probably as the result of the passing in the Queensland Parliament last session of the Act removing the embargo on foreign capital for oil prospecting, the Vacuum Oil Company has sent from America two of its field geologists (Drs. E. Jablongski and Carl Bremner) to this State to search for oil. They are now already at work in the Roma district.

VANCOUVER

June 9.

Anyox.—The condition of the copper market and curtailment of operations markedly affected Granby Consolidated Mining, Smelting and Power Company's earnings for the first quarter of this year. After providing for all costs

of operation but before allowing for depletion, depreciation, and taxes the company's earnings amounted to $688,386, which compares with $940,346, in the like period of 1929. The earnings for the first quarter are usually less than for any of the other three, as winter conditions usually necessitate the use of the auxiliary steam plant during part of the period. The Bonanza mine continues to develop well at depth, and it is reasonable to expect that a good reserve will be developed. At present the company is sending 400 tons daily along the tramway to Anyox. Last year the mine produced 112,489 tons, which yielded 4,242,507 lb. copper, 34,856 oz. silver, and 366 oz. gold. The company is exploring the Hidden Creek mine at greater depth. It has relinquished its option on the Hanna group of 16 claims, adjoining Hidden Creek, after making a geophysical survey which was followed up by diamond drilling at points indicated as promising by the survey.

THE HIDDEN CREEK MINE OF GRANBY CONSOLIDATED, ANYOX, B.C.

The Kootenays.—Consolidated Mining and Smelting Company of Canada has started to reopen its Molly Gibson mine on Mount Kokanee, which, but for occasional small amounts of productive mining by lessees, has been idle for 12 years. The mine is equipped with mining machinery and mill and, to date has produced 1,952 tons of ore that has yielded 531 oz. gold, 218,055 oz. silver, 5,864 lb. lead, and 1,074 lb. zinc. The company has started a cross-cut tunnel which is expected to reach the ore-body in 1,800 ft. and to give an additional depth of 1,000 ft. on the vein. The erection of a new camp has been started at the mouth of the tunnel and a flume is being constructed to bring water from Kokanee Creek for power purposes. A considerable tonnage of low-grade, highly siliceous gold-silver-lead-zinc ore is being shipped from the Goodenough mine, at Ymir, to Tadanac, where on account of its fluxing property it received the specially low treatment charge of 50 cents per ton. The mine, which at one time was bonded to Porcupine Goldfield D. and F. Company and later to Enterprise Mines, is now being worked by its owners and is giving promise of being developed into an important producer of low-grade ore, the chief value in which is in gold.

The Minister of Mines announced that to relieve the distress among the miners in the East Kootenay and Alberta bituminous coal fields the Government will apply a "subvention" of $1 per ton on all coal shipped to points near Winnipeg from those fields and a "subvention" of 50 cents per ton on briquettes so shipped from the Beinfait lignite field. Though the subvention is generally considered as a political move to forward the interest of the party in power at the election that will take place on July 28, the assistance will be received gratefully as it is expected it will enable the coal operators to compete with United States operators that now chiefly are supplying the Winnipeg market and thereby will give employment to a large number of men who have been out of work for some time.

Boundary.—Mr. J. F. Guest has made arrangements with French capitalists for the provision of $100,000 for the equipment and operation of his alluvial mining leases on Slate Creek and Collins Gulch, tributaries of the Tulameen River. Mr. Guest has been exploring these gravels for several seasons, and last year he installed a $1\frac{1}{4}$ cu. yd. bucket shovel and dragline equipment and a four-inch monitor. The last is used when the shovel is not in operation. He moved some 32,500 yards, which were said to have a value

of 44 cents in gold and platinum per yard. The amount of precious metals recovered is not known as much remains in black sand which has yet to be treated. Efforts have been made from time to time to recover gold and platinum from the gravels of the Tulameen and Similkameen Rivers, but, though some exceedingly rich spots have been found here and there, no long productive channel has been discovered. Some years ago an English syndicate financed the drilling of benches along the Tulameen, but, though no announcement as to values found was made, as no further work was done evidently the values found failed to interest the syndicate. A run-away car, freed by a break in the cable, recently killed A. J. Finch, manager of the Bell mine, on Wallace Mountain, and a member of the syndicate that recently acquired the mine.

Stikine River District.—A miniature stampede up the Stikine River has been caused by the discovery of copper-gold-silver ore, assaying $60 per ton by Mr. George Drapich, who has spent many years in the Yukon. The vein is said to be 30 ft. wide and is situated on the left bank of the river, about 100 miles above Wrangell. The assay was from a few pieces broken haphazard off the vein. Having recorded his claims, Mr. Drapich has returned to take out a shipment of 15 to 20 tons to get a smelter return. Consolidated Mining & Smelting Company has sent a party up the Iskut River to resume explorative work commenced last year along the Iskut River and a prospecting party to the north of the settlement of Telegraph Creek, and Mining Corporation of Canada has sent a party to resume work on a promising copper-gold discovery that was made last year near Glenora. As mineral deposits in this district seem to carry gold in association with base metals and silver, it makes the district more attractive in these days when base metals and silver are in the doldrums.

Portland Canal.—Despite the slump in the price of silver, its chief product, Premier Gold Mining Company has been able to maintain its dividend rate from the operation of its Premier mine, and has declared a dividend of 6% covering operations for the second quarter of this year. The profits from the operations of the Prosperity mine are devoted to the paying off the cost of development and equipment which Premier advanced. Premier owns 76% of the Prosperity mine, 55% of which was acquired chiefly in consideration for development and equipment and the remainder by subsequent purchase. During April Premier shipped 1,398 tons of ore, having an average value of $38·59 per ton from Prosperity and made a net profit of $29,118, which indicates excellent work when it is remembered that nearly the whole value of the ore is in silver. Since it brought the mine to production, in last November, it has shipped 7,038 tons, having an average value of $32·41, and has made a net profit of $93,242. It is unofficially reported that Premier has found a body of rich silver-lead ore in the D. tunnel of the Porter-Idaho mine, which is on a horizon 500 ft. below the loading terminus of the aerial tramway. The vein is said to be 6 to 7 ft. wide.

TORONTO

June 15.

Sudbury District.—International Nickel has reached the average rate of production of a little over 10,000,000 lb. nickel and rather more than 10,000,000 lb. copper per month. Vice-president J. L. Agnew, states that the output of nickel is in excess of demand, but that the company will continue its present policy for at least a year, after which, if conditions are not better, steps will be taken to curtail production. The Frood mine will be producing approximately 100,000 tons of ore per month, by July 1, and will shortly afterwards increase this to 125,000 tons. Operations at the Creighton mine have been curtailed, the amount of ore daily shipped to the smelter being reduced from 4,000 to 2,000 tons, and the re-opening of the Levack mine has been indefinitely postponed. The new smelter at Copper Cliff has gone into operation and the new refinery has been completed and will shortly be put into commission. It is officially announced that the Treadwell Yukon will make no change in its programme for the development of the Errington mine, on account of the low price of metals. In the developments to 500 ft., partial opening up of the known ore zone has indicated close to 800,000 tons in each 100 vertical feet. Should this condition prevail from the surface to 1,500 ft. in depth, where a large working station is now being cut, an aggregate of 12,000,000 tons of ore would be indicated in this comparatively moderate depth. This would provide a reserve for about 17 years at 2,000 tons daily. Development is being

actively carried on at the Falconbridge and sufficient ore is being taken out to maintain the mill in operation at capacity. Diamond drilling has been actively carried on and a fair grade of nickel-copper ore encountered at a depth of 2,000 ft. The Copper-Zinc Mines of Sudbury Ltd. has laid out an extensive programme of exploration and development of its property in the Sapawe Lake area, where operations last year yielded favourable gold assays. Exploration work on the newer prospects of this district has been discouraged by adverse market conditions, few of the occurrences offering opportunities for profitable development at present.

Porcupine.—The production of bullion in the Porcupine field during May, was valued at $1,545,110, being a slight decrease from the $1,561,925 reported for April, although the tonnage of ore milled in May was greater being 210,533 tons as compared with 205,810 tons. The mill of the Hollinger Consolidated is treating 4,600 tons of ore per day, of an average grade of $7 per ton, from which a monthly production of approximately $1,000,000 is being obtained. Some important new discoveries of ore have recently been made, and are being developed. The Dome mines is making good progress with the construction of its new 1,500 ton mill which is expected to be completed in about four months. The amalgamation process will be eliminated in favour of all-cyanidation and crushing facilities will be improved. Mine development has been actively carried on and has considerably increased the ore reserves, which are estimated at 1,300,000 tons, half of which is said to be broken. The annual report of the McIntyre-Porcupine for the fiscal year ending March showed net profits of $2,072,299, as compared with $1,903,313, for the previous year. The value of bullion recovered was $4,457,000, as against $4,212,224. Ore reserves were valued at $19,417,424, with an average grade of $8.30 per ton as compared with $16,179,205 of $8 a ton grade. At the Vipond a vein has been opened up on the 500 ft. level which shows a width of 11 ft. carrying $12 to the ton in gold. An important vein has also been encountered on the 1,000 ft. level. Surface showings on the Canusa property indicate the possibility of good commercial ore at depth and exploration including deep drilling has been planned on an extensive scale. The Paymaster Consolidated will shortly resume operations on the old West Dome Lake property.

Kirkland Lake.—The gold mines of this area during May produced bullion to the value of $1,349,969, as compared with $1,393,520 for the previous month. The Lake Shore continues to be the largest producer in this field, and good progress is being made with the enlargement of the mill, which will shortly go into operation. The mine has been developed down to the 2,200 ft. horizon, but there are still large sections on the upper levels that have hardly been touched. The development and expansion programme of the Teck-Hughes is being steadily carried out. The completion of the new shaft to 2,980 ft. connecting with a cross-cut the present main workings, opens the way to the development of several new levels. The new shaft will now continue to 3,700 ft. and will probably reach its objective by the end of the year. The construction of an additional unit to the mill will be undertaken this year, and this will raise the capacity to 1,200 or 1,300 tons per day. The mill of the Wright-Hargreaves is treating ore at the average rate of 700 tons per day, with an average recovery of about $11.50 per ton, showing a marked improvement in the grade of the ore. A rich vein coming in from the Lake Shore, is being opened up on the 1,750 ft. level and underground conditions are generally satisfactory. The annual report of the Sylvanite, for the fiscal year ending March, shows that 75,403 tons of ore were handled, with a recovery of $690,400, the average per ton being $9.16. The estimated tonnage of broken ore in the stopes was 55,807 tons. The total income from all sources was $710,637 and the expenses $683,942, leaving a profit of $26,694. Deep development operations at the Kirkland Lake gold mine have recently disclosed improved mineralization. Diamond drilling has encountered high-grade ore over a 3 ft. section at a depth of 4,200 ft., which is believed to be an off-shoot from the main ore-body. At the Barry Hollinger, in the Boston Creek section, the mill is treating 100 tons a day. A winze is being put down from the 1,625 to 1,875 ft. level, and has encountered good ore over its entire width.

Cobalt.—There has latterly been a marked revival of interest in the mines of Cobalt and the outlying silver producing areas, owing to the increased demand and high price of cobalt. The cobalt content

of the ore was formerly treated merely as a by-product, for which there was little demand. Market conditions having changed various old mining properties are being investigated for the purpose of learning the approximate tonnage of cobalt available and dumps of old shafts and the various outcroppings are being carefully prospected. The old La Rose mine, operations on which were suspended some years ago, is being dewatered and will again be operated with cobalt as the principal objective. The Cobalt Contact has entered upon the production stage and begun shipments of silver ore, the cobalt content being sufficient to defray working costs.

Patricia District.—The new mill of the Howey gold mine is now in regular operation handling an average of about 400 tons of ore per day and the initial shipment of gold bullion of the reported value of $75,000 was made last month. Underground work is being carried on below the 500 ft. level and a vein stated to be 76 ft. wide carrying good values has been encountered at the 875 ft. level. The shaft on the Central Patricia in the Crow River area is now down 500 ft. and lateral work at that horizon is being commenced The main vein has dipped away from the shaft and a cross-cut is being run to reach the deposit, about 80 ft. distant. The company has acquired 40 additional mining claims in the district. Diamond drilling on the Ontario Woman Lake property has disclosed ore of commercial value, and a test pit has encountered ore of a higher grade.

Manitoba.—The Flin Flon copper mine is now receiving power from the development at Island Falls and work is being speeded up. Good progress has been made with construction work on the various buildings, which should be ready for operations early in the autumn. Open-cut work has been started, and drilling and blasting, preparatory to mining, is being done. The main shaft has been completed and the ore-pockets on the 650 ft. level will be ready to handle ore when the mill goes into production. Steady progress is being made with development work on the Sherritt-Gordon mine. The main working shaft has been sunk 700 ft. on the incline, and stations cut at intervals. A crusher will be installed on the 500 ft. level, and a loading pocket 100 ft. below. The name of the Jack Nutt Mines Ltd. has been changed to the Consolidated Tin Corporation Ltd. The company has planned an extensive development campaign on its Bernic Lake property where a shaft is now down 175 ft., and will be completed to the 300 ft. level. Diamond drilling has indicated a large pegmatite dyke, carrying good tin values.

CAMBORNE

July 5.

The Price of Tin.—The price of tin remains at practically the same figure as that of a month ago, notwithstanding fluctuations between £133 and £140. Those fluctuations mark the sensitiveness of the tin metal market to passing influences originating from Eastern cables, changing prospects of the Tin Producers' Association scheme of restriction, or the publication of statistical information. Although at this price Cornish mines are unable to make a profit on working, fortunately the chief mines in the country are so placed financially by their judicious administration that they are not forced to yield to circumstances. They can still choose their mode of procedure during a stressful period of unremunerative prices.

Effects on the Position of Mines.—The latest monthly returns of the two largest mines, East Pool and Agar and South Crofty, show that operations are proceeding as usual, the two mines together crushing about 14,000 tons of ore per month. The average tonnage value of contents in both, however, is only about £1. On the assumption that working costs remain approximately the same as the average of last year, this would mean a loss of six or seven shillings a ton, but an adjustment of the development programme may be expected to somewhat lighten tonnage costs for the current year. Geevor is in an equally sound position and has wisely taken the opportunity to execute certain desirable improvements in the plant, especially in their air-compressing installation. This temporarily reduces the number of hands employed on rock-drill and other work. Economies in costs have been effected in several other mines, as might have been expected, and an effect of this is reflected in the increase in the figures officially issued in relation to unemployment. For example Redruth figures now exceed 1,000 unemployed, Camborne stands at 737, while St. Just, in the last few weeks, increased from about 100 to 300.

Jantar.—This mine continues to crush good ore. The crushing for May was 2,229 tons, which produced 29 tons of black tin,

the average extraction having been 29·2 lb. of black tin per ton. The development results have been very satisfactory for some time past. "Conversations" with representatives of a neighbouring property have been taking place recently, and it is not unreasonable to assume that, if these prove to be eventually satisfactory, an arrangement advantageous not only to both parties, but to the locality generally, may be completed.

Mount Wellington.—The prospecting operations which have been conducted at Mount Wellington have yielded such consistently good results that some important steps have been recently taken in connexion with this section of the old Gwennap United Mines, by the Argus Concessions, Ltd., under the local management of Messrs. R. C. N. Robinson and Co., who are satisfied that the results of exploration, and of sampling, (confirmed by bulk-crushing) justify them in capitalizing a company to work the property systematically. Accordingly the several leases have been completed, and a favourable opportunity has been taken to acquire a modern mill having a capacity of 120 tons per day. This mill, however, will not be immediately put into commission, because, in the present state of the tin market, operations will be confined to the further development of the lodes. The immediately adjacent mines, especially in the first half of the last century, were very successfully wrought, at comparatively shallow depths, for copper, ores of which to the value of over £2,000,000 were sold, besides quantities of tin, arsenic and blende. The Mount Wellington lodes are tin lodes, and although a little opencast work was done, 80 or 90 years ago, on a portion of one of them, they appear to have escaped further attention till, during the war, two brothers re-opened the old working and, within three years, recovered 14 tons of black tin which they sold for about £100 a ton. The ore was transported by horse-and-cart to little primitive Cornish stamps, further down the Carnon Valley, and a recovery of 30 lb. of black tin per ton was effected. This ore came from the outcrop of one of the lodes, the deeper portion recently opened up by means of an adit driven by the Argus Concessions, Ltd., not then being available. This adit rendered access easy to deeper portions of the lode. Extensive sampling has resulted in establishing the existence of a large lode, averaging fully 30 lb. of black tin per ton over a width of 12 to 15 ft. It is reckoned that 100,000 tons are already made available for stoping, above the new adit level, and that the tonnage will increase rapidly as extension is made into the hill.

PERSONAL

A. E. Andrews is home from New Guinea.
H. Arnall has left for Nigeria.
H. Foster Bain passed through London on his way to the United States.
E. A. Baring-Gould is home from Spain.
W. Begg has gone to New Zealand.
J. G. Bottoms is home from Uganda.
A. O. Brown is visiting Spain and Portugal.
J. W. Cairns has left for Northern Rhodesia.
James Caldwell has left for Mexico.
Charles Camsell has returned to Canada.
J. A. Chennells is home from Uganda.
L. Maurice Cockerell has returned from Italy.
H. G. D. Dixon has left for Spain.
A. J. Gilbert is home from Uganda.
J. H. Graham is returning from Malaya.
Maurice Gregory has returned from Abyssinia.
Richard Harvey is returning from Portugal.
J. A. L. Henderson has left for Canada.
James Hocking is home from Spain.
Edward Hooper is visiting South Africa.
W. Brooke Howard has left for Mysore.
C. E. Hutchings is returning from Macedonia.
W. Harvey Laity has returned to Northern Rhodesia.
R. H. Mitchell is returning from Nigeria.
A. M. Moon is home from Panama.
N. E. Odell is visiting British Columbia prior to returning to London in September.
P. E. Raine has returned lately from abroad.
R. S. H. Richards is home from Portugal for a short stay.
Edgar Rickard passed through London on his way to the Continent.
J. E. Snelus has returned from Nigeria.
George E. Stephenson is home from Cyprus.
G. W. Thomson has left for New Zealand.
Scott Turner, Director of the United States Bureau of Mines, has received the honorary degree of Doctor of Engineering of the University of Michigan and the honorary degree of Doctor of Science from the Colorado School of Mines.
L. Vaughan is home from Malaya.
H. B. Wall is home from Malaya.
H. Watson is home from Panama.
A. B. Watson has left for West Africa.
C. H. Wray is leaving for Dutch Guiana.

Louis Henry Timmins, of Montreal, a pioneer of the Cobalt and Porcupine mining fields of Northern Ontario, died on June 1 at the age of 70 years. Born at Mattawa, Ont., he was originally engaged in the lumber business in partnership with his brother, Noah A. Timmins. In the early days of the Cobalt camp they became interested in mining and secured the La Rose mine, and when gold was discovered in Porcupine, the Timmins Brothers helped to establish the Hollinger Consolidated, of which Mr. Noah A. Timmins became president.

TRADE PARAGRAPHS

Watt Car and Wheel Co., of Barnesville, Ohio, issue a leaflet giving some particulars of the W.A.G. coal dumping system, also details of various of their other specialties.

Workington Iron and Steel Co., a branch of the United Steel Companies, Ltd., of Workington, issue a catalogue setting out the advantages of steel sleepers for railway track work.

Adam Hilger, Ltd., of 24, Rochester Place, London, N.W. 1, send us Bulletin No. 2 on the subject of spectrum analysis, which deals with quantitative analyses of metals by means of a spectrograph, and correlated information.

Askania-Werke, A.G., of Bambergwerk, Berlin-Friedenau, Germany, inform us that they are exhibiting at the International Exhibition at Liege, and in connexion with this they have published a catalogue in the French language, fully illustrated and giving particulars of all the instruments which they manufacture both for geophysical and other purposes.

R. Hudson and Sons, Ltd., of Leeds, have established a factory at Congella, near Durban, in South Africa, for the local manufacture, among other things, of mine trucks. It is not generally known that these works have been in existence for about two years and that they cover a considerable area. It is interesting to recall that their standard mining tip truck is used in thousands on many mines in different parts of the Empire.

Electric Furnace Co., Ltd., of 17, Victoria Street, London, S.W. 1, send us particulars of the proceedings of their annual general meeting which discloses that their new subsidiary company, the Electric Resistance Furnace Co., Ltd., has experienced a year of great activity, while the main business of the company in melting furnace plant has been satisfactory when consideration is allowed for the general depression in heavy industries.

International Geophysical Prospecting Co., Ltd., of 20, High Holborn, London, W.C. 1, draw our attention to the proceedings of their second annual general meeting, in the course of which the Managing Director, Mr. J. C. Templeton, in referring to the activities of the company and to the value of geophysical surveying and also to the international character of this work, disclosed the interesting fact that they have 15 Englishmen actively engaged on work being undertaken by the company.

Sullivan Machinery Co., of Salisbury House, London, E.C. 2, issue a catalogue describing their portable air-compressors. This is very fully illustrated with typical examples of work in hand with these machines, together with details of their essential parts. The catalogue also contains particulars of tools to be operated with these compressors and of hoists which are worked with compressed air. These compressors are made for air displacements of from 66 to 310 cu. ft. per min. with corresponding h.p. developed at engine speed of 18 and 67 respectively on petrol. They also issue a leaflet describing the Sullivan simplified jib for use in colliery operations.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment:—For England: One 4 ft. by 7 ft., type 39, Hum-mer screen for coal. For Sweden: Two R.L. 9 R-Lopulco mills for grinding coal at 5¼ tons per hour, each mill, to 90% through 100 mesh; one No. 0000 Raymond pulverizer for grinding foundry coal at 100 K. per hour to 190 mesh. For France: One No. 00 Raymond pulverizer for resin; two 5-roller double cone Raymond mills for 3½ tons per hour per mill Gafsa phosphate, at 95% through 200 mesh; three 2 ft. by 8 in. Hardinge mills for grinding mineral at 100 lb. per hour per mill, to 95% through 100 mesh; one type 37, 2-surface Hum-mer screen for un-named duty. For Tunisia: One Raymond super mill for grinding Gafsa phosphate 13–15 tons per hour to 95% through 200 mesh.

Kinetic Elutriators, Ltd., of 11, Southampton Row, London, W.C. 1, recently afforded us an opportunity of inspecting an installation of the Andrews hydraulic classifier working in closed circuit with a Hardinge conical mill for grinding an abrasive mineral. This classifier was described here in November 1927 and February 1928. Interest nevertheless attaches to the two photographs reproduced here. Fig. 1 shows a cross-sectional elevation of the spiral vortex in which classification is effected, and Fig. 2 is a view looking down on the cone and indicates how absolutely smooth and unrippled is the surface of the fine overflow. In this case the plant is overflowing half-ton per hour of material 99·9% −200 mesh, of which 50% is less than 0·01 mm., or an equivalent

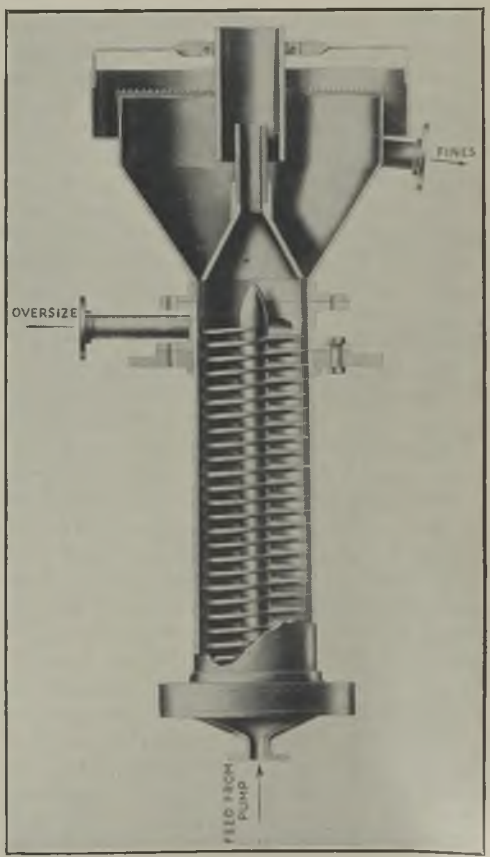


FIG. 1.—CROSS-SECTION OF AN ANDREWS HYDRAULIC CLASSIFIER.

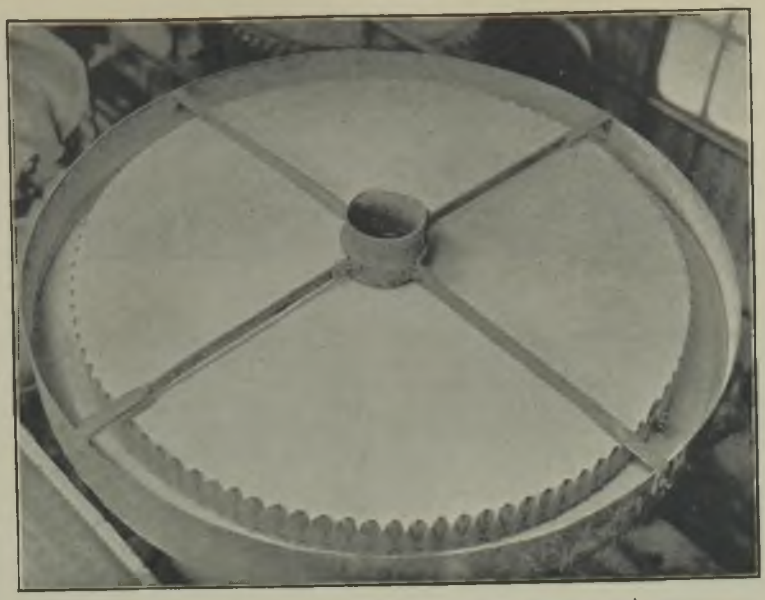
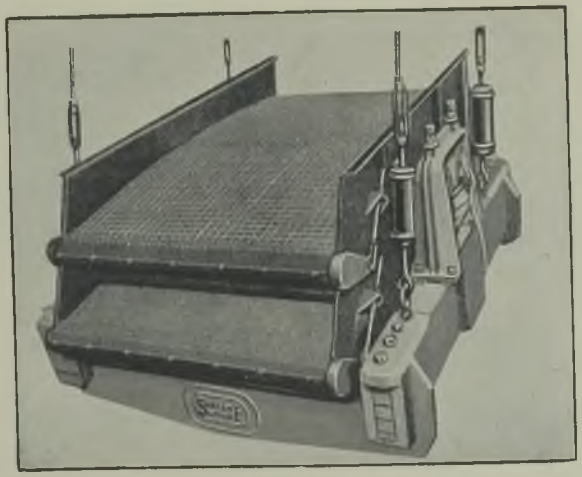


FIG. 2.—ACTUAL VIEW LOOKING DOWN ON TOP OF AN ANDREWS HYDRAULIC CLASSIFIER.

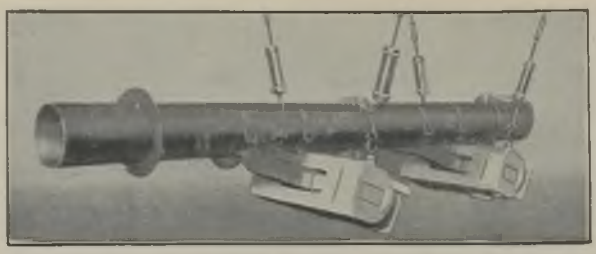
of −1,200 mesh. The density of the overflow is about 12 of water to 1 of solid by weight. The oversize returned to the mill is notably clean or free from fines. The diameter of the head is 3 ft. 6 in. The plant in question has been in continuous operation for 10 months and is giving complete satisfaction to the users.

Ruston-Bucyrus, Ltd., of Lincoln, issue particulars of the Ruston-Bucyrus 1030 machine which is a ¾ cu. yd. internal combustion engine or electrically driven excavator, the first of a new series to be manufactured by the firm at Lincoln. It fills in a gap between the No. 4 ½ yd. and No. 6 1 yd. machines at one time manufactured by Ruston and Hornsby, Ltd. The present is a full circle type convertible for use as shovel, dragline, drag shovel, grabbing crane, or crane. The power is provided either by a four cylinder Diesel engine of 59 h.p. or a four cylinder petrol engine of 72½ h.p. or by means of an a.c. or d.c. motor of 40 h.p. and if necessary a motor may be added upon the jib, to operate the racking gear in place of the rope thrust gear which is fitted.

Thomas Locker and Co., Ltd., of Warrington, have sent us further particulars of their screening and conveying specialities. In a reference to these products here in the April issue a photograph of one of the " Supreme " screens handled by them was reproduced. This was an early type which has been considerably improved upon. We now give an



"SUPREME" DOUBLE-DECK VIBRATING SCREEN.



Locker Tubular Vibrator.

illustration of the double-deck type of screen (FB 4) and also of the tubular form of the vibrator conveyor also mentioned on the previous occasion.

Bailliere, Tindall and Cox, of 7 and 8, Henrietta Street, London, W.C. 2, issue a catalogue of their publications in science. Although this is chiefly taken up with medical text books there is a section covering chemistry, petroleum technology, metallurgy, and such like.

Bessler, Waechter and Co., Ltd., of Salisbury House, London, E.C. 2, write us with regard to Diesel locomotives for light railways, which, they point out, have been proved to be the most economical means of rail haulage. There has been a reluctance, however, to employ engines of this type because the Diesel locomotive, like the petrol locomotive before it, was far from reliable when introduced and the many breakdowns which occurred with the earlier semi-Diesel and hot-bulb types did little to convince possible users of the advantages of Diesel haulage. These difficulties have long been overcome, and the Diesel locomotive is now not only as reliable as the light steam locomotive but is said to be even less complicated than the petrol locomotive. The difficulty to be overcome was that of rapidly injecting perfectly atomized fuel into the combustion chamber without the danger of imperfect combustion. A form of fuel injector was devised which fulfilled its requirements in respect of perfect atomization and uniform and rapid injection of the heavy fuel. Perfect combustion of the fuel has also been achieved by a patent combustion chamber which does not explode the whole injection simultaneously but burns the fuel during the complete down or power stroke of the piston. In the early days of the internal combustion locomotive it was thought sufficient if a powerful lorry engine was mounted on a wagon underframe, the axles of which were coupled to the engine. This was quite a simple arrangement and was adopted by many manufacturers. The assumption that this type of machine would meet the strenuous conditions under which light railways operate was soon proved to be incorrect in practice and the majority of the makers ceased manufacturing these machines. Montania motor locomotives, however, made by Orenstein and Koppel A.G., of Berlin, are the outcome of experience in both steam and internal combustion railway engine practice. The engine and underframe are in coordination and consequently the maximum specified load is hauled from dead start. There is no slipping when the train is started and although sanding gear is fitted it is usually only used on wet track. The initial cost of the Diesel locomotive is slightly higher than that of the petrol locomotive, but a considerable saving in fuel cost is effected. In addition, lubricating oil consumption is reduced to a minimum and on the Montania machines for instance, which operate on the four-stroke principle, it is guaranteed not to exceed more than 3 to 5% of the guaranteed fuel-oil consumption and is usually less. The firm also send us catalogues and we reproduce here a photograph showing the sturdy design of these engines.

Montania Diesel Locomotive.

Ruston and Hornsby, Ltd., of Lincoln, who recently effected an alliance with the Bucyrus Erie Company to assist their excavator business have now entered into an important working arrangement with **R. A. Lister and Co., Ltd.,** of Dursley to ensure efficient coordination in the design, production, and sales of oil engines. Listers will concentrate on engines up to 25 h.p., a new light high speed cold starting Diesel engine of between 25 and 100 h.p. will be produced jointly, and Ruston's will continue the manufacture of larger engines as formerly. Mr. G. R. Sharpley, managing director of Ruston and Hornsby will join the Lister board and Mr. Percy Lister will join Ruston's

Escher Wyss and Co., S.A., of 20, Grosvenor Gardens, London, S.W. 1, inform us that they have been successful in securing a contract for two large turbo-blowers, each arranged with individual turbine drive, to be operated in conjunction with blast furnaces of the Tata Iron and Steel Co., in India. Each will normally take in 130,000 cu. ft. per min. of air which will be delivered at a pressure of 25 lb. per sq. in. The turbines driving these blowers will have a normal output of 13,700 h.p. each. The operating conditions will be severe as not only have large variations in load to be met, demanding corresponding changes of speed, but the machines must also be capable of operating over long periods under the control of automatic volume regulators and delivering very accurately fixed quantities of air. They also send us a copy of a back number of their periodic publication, which contains an article on hydraulic consideratons for the lay-out of pipelines, also an illustrated article on geared vertical water turbines.

METAL MARKETS

COPPER.—The trend of copper values in America during June was downwards, the quotation of the Copper Exporters Inc. receding from 13 cents to 12 cents per lb., whilst at one time the latter figure was under-quoted by "outsiders" on the American domestic market. Sentiment was rather jarred by the American May statistics, as, despite increased deliveries, stocks were shown to have expanded further, mainly owing to an unexpected rise in the output. Fresh demand for copper seems to have been quiet of late, following the heavy buying witnessed some weeks ago, but producers are hinting that as a result of previous big sales, the June statistics are likely to reveal a reduction in their stocks. The situation of the copper producers remains rather unenviable however as they are still burdened with a big surplus and consumption does not yet appear to have broadened very substantially as a result of the cut in prices. Standard copper prices in London have been rather weak in sympathy with American advices.

Average price of cash standard copper: June, 1930, £50 1s. 4½d.; May, 1930, £53 5s.; June, 1929, £74 7s. 9d.; May, 1929, £75 2s. 6d.

TIN.—After displaying pronounced weakness in the early part of June, tin values have rallied somewhat, but nevertheless reflect a distinct loss on the month. Fresh efforts on the part of the Tin Producers' Association to "stop the rot" have not had very much effect, as sentiment has been again shaken by further additions to "world visible supplies" and by doubts as to whether the latest proposal that mines should shut down for two months will receive serious support. The market is obviously being affected at present far more by the laws of supply and demand than by the activities of manipulators and speculators, and in view of general conditions it would not be in the least surprising if still lower price levels are touched before the market begins to react.

Average price of cash standard tin: June, 1930, £136 7s. 8d.; May, 1930, £144 18s.; June, 1929, £200 5s. 9d.; May, 1929, £197 12s. 8d.

LEAD.—This market has been one of the best on the London Metal Exchange, prices having been well maintained, on balance. There has been quite a good demand from home consumers and fresh arrivals of metal have been moderate, whilst sellers have maintained a firm grip on their big warehouse stocks. As a result, although there is no actual shortage of lead, premiums have been obtained for early deliveries. Continental interest in the metal, however, has been rather disappointing. In America, the quotation has been reduced from 5·50 to 5·25 cents per lb., owing to the fact that, despite a reduction in output, stocks have again tended to expand.

Average mean price of soft foreign lead: June, 1930, £17 19s. 4d.; May, 1930, £17 16s. 6d.; June, 1929, £23 12s. 11d.; May, 1929, £23 16s. 11d.

SPELTER.—Demand from consumers has continued disappointing so that much of the activity on 'Change has been of a professional character. Despite the slow progress of the negotiations directed towards re-establishing the Zinc Cartel, the situation is probably gradually becoming somewhat healthier. The Belgian works, for instance, are reported to have cut down their output drastically, and there is not much doubt that other plants are adopting similar measures, so that surplus stocks are likely to be reduced. The "fly in the ointment" on the other hand is the slowness of demand from consumers, who are themselves handicapped by an unsatisfactory demand for their own products.

Average mean price of spelter: June, 1930, £16 14s. 7d.; May, 1930, £16 19s. 8d.; June, 1929, £26 2s.; May, 1929, £26 13s. 4d.

IRON AND STEEL.—The month of June was a gloomy one for the blast furnaces on the North-East Coast. Demand for both foundry and hematite material was dull, and output was cut down further. The minimum prices of Cleveland foundry and forge grades have remained unchanged, with No. 3 foundry quoted at 67s. 6d. per ton, but it is understood that concessions are being made for Scottish business. Hematite has been weak, despite a big long-term order recently placed by Sheffield interests, and East Coast Mixed Numbers would probably be obtainable at less than 71s. 6d. for good orders. As regards finished iron and steel, the situation remains unsatisfactory, both as regards British and Continental material, owing to poor demand.

ANTIMONY.—At the close of June, English regulus was quoted at between £38 and £46 10s per ton. Chinese regulus was quiet, with spot material priced around £26 to £26 5s. ex warehouse and with sellers of metal for shipment from China asking about £22 5s. per ton, c.i.f.

IRON ORE.—No fresh business has been forthcoming recently, the overbought condition of works being only too apparent, while the closing down of blast furnaces has aggravated the position. Best Bilbao rubio is still priced nominally at 20s. per ton c.i.f., but less would probably be accepted.

ARSENIC.—Cornish 99% white is moving slowly at about £15 15s. per ton f.o.r. mines.

LONDON DAILY METAL PRICES

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

	COPPER.			TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	Standard.		Electrolytic.	Best Selected.			Soft Foreign.	English.			
	Cash.	3 Months.			Cash.	3 Months.			Cash.	Forward.	
June	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	50 16 3	51 3 9	60 0 0	—	135 8 9	137 8 9	16 10 0	18 0 0	19 10 0	16 7/8	16 1/2	85 0 1/2
12	49 15 0	50 1 3	59 0 0	—	134 18 9	136 16 3	16 11 3	17 17 6	19 10 0	16 3/4	16	85 0 1/4
13	48 18 9	49 3 9	58 0 0	57 0 0	133 16 3	135 11 3	16 11 3	17 16 3	19 5 0	16 3/4	16	84 11 3/4
16	47 6 3	47 11 3	55 0 0	—	133 8 9	135 3 9	16 8 9	17 15 0	19 5 0	15 15/16	15 7/8	84 11 3/4
17	47 3 9	47 6 3	55 0 0	54 5 0	132 12 6	134 12 6	16 6 3	17 17 6	19 5 0	15 15/16	15 7/8	85 0
18	46 18 9	47 3 9	54 10 0	—	133 8 9	135 2 6	16 7 6	17 17 6	19 5 0	15 15/16	15 7/8	85 0
19	50 6 3	50 11 3	54 15 0	—	138 7 6	140 2 6	16 12 6	17 17 6	19 5 0	15 15/16	15 15/16	85 0
20	49 16 3	49 16 3	56 0 0	54 5 0	138 17 6	140 12 6	16 11 3	17 17 6	19 5 0	15 15/16	15 7/8	85 0
23	48 8 9	48 8 9	55 10 0	—	134 3 9	136 3 9	16 5 0	18 0 0	19 5 0	15 7/8	15 7/8	85 0
24	48 18 9	48 18 9	55 10 0	54 5 0	136 13 9	138 12 6	16 5 0	18 0 0	19 10 0	15 7/8	15 1/2	85 0 1/2
25	48 11 3	48 11 3	55 10 0	—	139 12 6	141 12 6	16 2 6	17 18 9	19 10 0	15 7/8	15 3/4	84 11 1/2
26	49 6 3	49 6 3	55 10 0	—	136 12 6	138 12 6	16 2 6	18 0 0	19 10 0	15 7/8	15 5/16	85 0
27	49 6 3	49 4 4 1/2	55 10 0	54 5 0	137 13 9	139 12 6	16 1 3	18 3 9	19 10 0	15 15/16	15 1/2	85 0
30	49 3 9	49 1 3	55 10 0	—	136 13 9	138 13 9	16 3 9	18 3 9	19 10 0	15 1/2	15 5/16	85 0
July												
1	50 1 3	49 11 3	55 10 0	54 5 0	135 13 9	137 13 9	15 18 9	18 1 3	19 10 0	15 11/16	15 3/8	85 0 1/2
2	49 15 0	48 18 9	55 10 0	—	136 13 9	138 13 9	15 16 3	17 17 6	19 5 0	15 3/8	15 1/16	85 0 1/2
3	49 5 0	48 6 3	55 10 0	—	136 18 9	138 17 6	15 15 0	17 16 3	19 5 0	15 1/8	15 1/16	85 0
4	49 2 6	48 1 3	55 10 0	54 5 0	135 12 6	137 6 3	16 1 3	18 1 3	19 10 0	15 1/8	15 1/16	85 0 1/2
7	48 13 9	47 16 3	55 10 0	—	135 1 3	136 17 6	15 18 9	18 0 0	19 10 0	15 1/8	15 1/16	85 0 1/2
8	48 7 6	47 18 9	55 10 0	54 5 0	134 8 9	136 6 3	15 15 0	18 0 0	19 10 0	15 1/16	15	85 0 1/2
9	47 16 3	47 14 4 1/2	54 10 0	—	133 8 9	135 6 3	15 15 0	18 2 6	19 10 0	15 1/16	15 1/16	85 0 1/2
10	47 13 9	47 8 9	54 10 0	—	130 6 3	132 3 9	15 12 6	18 2 6	19 10 0	16 1/16	16	85 0 1/2

Bismuth.—A moderate business continues at the official price of 4s. per lb. for 5 cwt. lots and over.

Cadmium.—With only a limited enquiry, and additional supplies coming here from America where consumption is slack, prices have eased to about 3s. 6d. to 3s. 7d. per lb.

Cobalt Metal.—Demand has been distinctly slow owing to the quietness of the high speed steel industry, but the official price is still 10s. per lb.

Cobalt Oxides.—Quotations remain unaltered at 8s. per lb. for black and 8s. 10d. for grey.

Chromium.—A fair business is passing with platers, the price keeping steady at 2s. 6d. per lb.

Tantalum.—The price is still somewhere in the neighbourhood of £40 to £50 per lb.

Platinum.—The official price of refined metal has remained steady for some weeks at £8 15s. per oz., but as usual this figure is shaded in the open market.

Palladium.—Demand has been rather slack recently and current quotations are about £4 10s. to £4 15s. per oz.

Iridium.—Sellers have made a further advance in the price of sponge and powder to £51 10s. per oz., but only a very limited demand has ensued.

Osmium.—The strength of iridium has had some reflection in Osmium prices which are now about £14 15s. to £15 10s. per oz.

Tellurium.—Business remains at a standstill and quotations are purely nominal at 12s. 6d. to 15s. per lb.

Selenium.—High grade black powder continues to change hands steadily at about 7s. 8d. to 7s. 9d. per lb. ex warehouse, Liverpool.

Manganese Ore.—The absence of fresh buying interest remains complete, but it is obvious that, despite its grumblings about the low prices, the Soviet is still a ready seller at cheap levels should business offer. Current quotations might be called about 1s. 1½d. per unit c.i.f. for best Indian and 1s. 0¼d. to 1s. 0½d. c.i.f. for washed Caucasian.

Aluminium.—The only interesting features of this market are the facts that the new import duty in America has become law and the probability that the German import duty of 250 Marks per ton will be imposed on July 15. Demand generally remains slow, but quotations are unaltered at £95, less 2% delivered, for ingots and bars.

Sulphate of Copper.—English makers are still quoting £24 10s. to £25 per ton, less 5%.

Nickel.—Business latterly has shown some falling away, and production is admittedly running rather ahead of consumption. Prices, however, remain at £170 to £175 per ton.

Chrome Ore.—The feature of this market is the rapidly increasing number of sources of chrome ore which are being developed. For the time being, however, quotations are upheld at the old levels of £4 2s. 6d. to £4 7s. 6d. per ton c.i.f. for good 48% ore.

Quicksilver.—The small spurt of buying interest seen about a month ago quickly subsided and current demand is very meagre. Prices stand at about £22 12s. 6d. to £22 15s. per bottle, full terms, for spot material.

Tungsten Ore.—Buyers have withdrawn from the market, and with the Chinese exchange falling and sellers anxious to attract business quotations have fallen sharply, the present value of July–August shipment from China being around 14s. 6d. to 15s. per unit c.i.f.

Molybdenum Ore.—About 32s. 6d. to 33s. represents the current value of 80 to 85% concentrates, but no business is passing.

Graphite.—Only small lots are in request, 85 to 90% raw Madagascar flake being about £25 to £27 per ton c.i.f. and 90% Ceylon lumps about £24 to £26 c.i.f.

Silver.—The past month has been a tragic one for the silver mining industry. Spot bars opened the month at $17\frac{3}{16}$d. in June 2. Poor demand and the slump in the Chinese exchange, causing heavy selling pressure from that quarter, forced prices down rapidly until, on June 24, spot bars touched $15\frac{7}{16}$d. Subsequently a little recovery was seen, but the market is in anything but a strong position and quotations may quite possibly make fresh low records. Spot bars closed at 15¾d. on June 30.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
June, 1929	821,352	34,677	956,029
July	853,370	36,110	889,480
August	850,952	38,649	889,601
September	814,707	34,846	849,553
October	853,609	35,081	888,690
November	827,952	33,641	861,593
December	813,574	37,560	851,134
January, 1930	848,245	34,556	882,801
February	783,086	35,102	818,188
March	852,089	37,281	889,370
April	831,996	36,610	868,606
May	876,839	39,320	916,213
June	847,352	40,515	887,867

TRANSVAAL GOLD OUTPUTS.

	May.		June.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	80,000	£140,955	85,000	£136,964
City Deep	102,000	26,534	97,500	25,665
Cons. Main Reef	61,000	22,061	62,000	21,752
Crown Mines	250,000	78,982	245,000	78,117
D'rb'n Roodepoort Deep	41,500	14,406	42,500	13,854
East Rand P.M.	155,500	42,644	151,000	40,775
Geduld	86,000	27,290	83,000	26,442
Geldenhuis Deep	70,800	16,031	68,100	15,092
Glynn's Lydenburg	6,800	2,145	6,500	2,189
Government G.M. Areas	212,000	£405,541	196,000	£380,534
Kleinfontein	52,400	11,168	51,800	11,095
Langlaagte Estate	82,000	£118,644	79,000	£114,706
Luipaard's Vlei	28,300	7,118	27,500	7,046
Meyer and Charlton	17,700	£19,656	17,800	£18,882
Modderfontein New	160,000	74,317	154,000	72,807
Modderfontein B	71,500	24,405	69,000	23,994
Modderfontein Deep	45,900	23,934	43,000	22,511
Modderfontein East	69,500	20,259	68,000	19,699
New State Areas	79,000	£158,560	76,000	£155,800
Nourse	62,400	18,179	64,500	18,236
Randfontein	226,000	£235,252	220,000	£229,053
Robinson Deep	146,000	37,474	141,000	35,414
Rose Deep	62,000	13,457	60,300	13,217
Simmer and Jack	78,500	21,116	77,300	20,542
Springs	72,500	£150,552	66,700	£140,071
Sub Nigel	29,900	25,234	30,000	25,785
Transvaal G.M. Estates	15,434	4,955	14,870	4,363
Van Ryn	42,000	£42,479	41,000	£41,285
Van Ryn Deep	67,000	£107,276	61,000	£104,331
West Rand Consolidated	92,000	£104,889	90,000	£103,573
West Springs	69,500	£79,929	67,600	£76,573
Witw'tersr'nd (Knights)	57,000	£54,607	54,000	£51,525
Witwatersrand Deep	43,500	13,457	41,000	13,020

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.	£
April, 1929	2,606,420	28 1	19 11	8 2	1,068,103
May	2,694,610	28 0	19 10	8 2	1,100,461
June	2,543,550	28 3	19 10	8 5	1,065,191
July	2,649,560	28 1	19 8	8 5	1,112,246
August	2,661,800	28 1	19 9	8 4	1,111,834
September	2,530,370	28 2	19 10	8 4	1,056,839
October	2,658,100	28 1	19 8	8 5	1,115,744
November	2,559,450	28 3	19 11	8 4	1,071,199
December	2,528,000	28 3	19 11	8 4	1,058,231
January, 1930	2,618,600	28 2	19 9	8 5	1,103,718
February	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,230	28 7	20 1	8 6	1,084,504
May	—	—	—	—	1,153,549

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
June 30, 1929	192,595	15,928	5,029	213,552
July 31	190,031	15,914	4,845	210,790
August 31	190,062	15,867	5,071	211,000
September 30	190,567	15,733	4,814	211,114
October 31	189,739	15,533	4,555	209,827
November 30	186,941	15,320	4,561	206,822
December 31	184,280	15,326	4,811	204,417
January 31, 1930	190,663	15,288	5,889	211,840
February 28	196,752	15,495	6,584	218,831
March 31	200,134	15,350	7,002	222,316
April 30	202,434	15,109	5,565	223,108
May, 31	202,182	15,028	5,340	222,550
June 30	201,324	14,943	5,126	221,393

PRODUCTION OF GOLD IN RHODESIA.

	1927	1928	1929	1930
	oz.	oz.	oz.	oz.
January	48,731	51,356	46,231	46,121
February	46,461	46,286	44,551	43,385
March	50,407	48,017	47,388	45,511
April	48,290	48,549	48,210	45,806
May	48,992	47,323	48,189	—
June	52,910	51,762	48,406	—
July	49,116	48,960	46,369	—
August	47,288	50,611	46,473	—
September	45,838	47,716	45,025	—
October	46,752	43,056	46,923	—
November	47,435	47,705	46,219	—
December	49,208	44,772	46,829	—

RHODESIAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,000	11,055	24,400	10,995
Globe and Phœnix	6,062	5,451	6,146	5,724
Lonely Reef	6,000	3,831	5,800	3,792
Luiri Gold	1,543	£2,658	1,579	£3,386
Rezende	6,400	2,712	6,400	2,710
Sherwood Star	5,000	£13,980	5,000	£14,000
Wanderer Consolidated	15,800	4,075	15,300	3,976

WEST AFRICAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	6,000	10,100	—	—
Ashanti Goldfields	10,555	12,251	10,768	12,487
Taquah and Abosso	9,600	£15,922	9,053	£14,965

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
June, 1929	33,139	2,368	465
July	28,086	1,421	1,203
August	37,032	2,178	567
September	32,751	1,739	381
October	35,445	—	789
November	28,460	—	473
December	33,650	1,459	1,636
January, 1930	25,472	952	209
February	31,307	1,354	350
March	27,946	2,562	382
April	36,652	1,812	1,081
May	32,967	—	—
June	41,738	—	—

AUSTRALASIAN GOLD OUTPUTS.

	May.		June.	
	Tons.	Value £	Tons	Value £
Associated G.M. (W.A.)	5,358	8,538	4,948	8,761
Blackwater (N.Z.)	4,000	7,158	3,260	5,530
Boulder Persev'ce (W.A.)	7,029	16,857	7,007	15,381
Grt. Boulder Pro. (W.A.)	9,176	24,029	9,632	23,727
Lake View & Star (W.A.)	6,445	23,326	—	—
Sons of Gwalia (W.A.)	13,522	13,934	13,738	13,068
South Kalgurli (W.A.)	8,874	15,555	8,291	15,869
Waihi (N.Z.)	18,164	{ 5,812* / 39,713†	17,265	{ 6,373 / 31,939

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	May.		June.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	4,150	1,954	3,200	1,953
Champion Reef	8,900	5,834	8,095	5,374
Mysore	17,239	8,387	16,693	8,252
Nundydroog	12,011	7,508	11,500	6,967
Ooregum	13,500	6,036	12,000	5,303

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	May.		June.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,620	10,684	8,970	12,475
Frontino & Bolivia (C'lbia)	2,500	8,250	2,320	9,774
Lena (Siberia)	—	—	—	—
Lydenburg Plat. (Trans.)	3,650	778*p*	3,470	694*p*
Marmajito (Colombia)	920	5,739	870	5,128
Fresnillo	89,338	32,640*d*	—	—
Onverwacht Platinum	3,050	376*p*	1,044	101*p*
Oriental Cons. (Korea)	—	91,500*d*	—	74,500*d*
St. John del Rey (Brazil)	—	46,000	—	43,500
Santa Gertrudis (Mexico)	44,864	97,242*d*	44,092	87,312*d*

d Dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1929	5,802	January, 1930	6,128
August	5,610	February	4,768
September	5,332	March	5,763
October	5,966	April	5,407
November	6,135	May	6,043
December	5,849	June	5,590

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	April	May.	June.
Ayer Hitam	101½	95½	78½
Batu Caves	29	27	28
Changkat	50	63	75
Chenderiang	29	42	—
Gopeng	62½	62½	65½
Hongkong Tin	89½	51	71½
Idris Hydraulic	29¾	29¾	29¾
Ipoh	40¾	38	52½
Jelapang	28	31	26
Kampar Malaya	83	69	66
Kampong Lanjut	50	90	85
Kamunting	116	106	92
Kent (F.M.S.)	28½	25	18
Kepong	33	36	37
Kinta	21	24	22½
Kinta Kellas	18	29¾	26¾
Kuala Kampar	70	65	80
Kundang	29	22	30
Lahat	15½	15¾	15
Larut Tinfields	45½	36	35
Malaya Consolidated	42	72½	82½
Malayan Tin	119	119	119
Meru	24	13½	18
Pahang	225	225	224½
Penawat	42	85½	119½
Pengkalen	48	45	53½
Petaling	178½	173	158
Rahman	56½	71½	77½
Rambutan	9½	9	10½
Rantau	46	48	36
Rawang	90	90	80
Rawang Concessions	30	45	40
Renong	50½	108	96
Selayang	24	23	—
Southern Malayan	154¾	154¾	154¾
Southern Perak	89¼	98¼	84
Southern Tronoh	60	81	71
Sungei Besi	45	45	45
Sungei Kinta	41	12¾	15
Sungei Way	77½	83½	78½
Taiping	36	48	41
Tanjong	30	27	35¾
Teja Malaya	43	45¼	36½
Tekka	42	36	38½
Tekka-Taiping	51	57	65½
Temoh	41½	31	29¾
Tronoh	72	69	68

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	April	May.	June.
Amari	6	6	—
Anglo-Nigerian	83½	94	83
Associated Tin Mines	200	200	170
Baba River	12	16½	10
Batura Monguna	1¾	1½	1¼
Bisichi	65	65	65
Daffo	—	—	7½
Ex-Lands	50	55	—
Filani	2¼	2½	2½
Jantar	26	26	26
Jos	17½	22	18
Juga Valley	16	20	17
Junction	5	6	6
Kaduna Syndicate	37	59	—
Kaduna Prospectors	23	22	—
Kassa	15½	27	19½
London Tin	220	220	220
Lower Bisichi	4¾	7½	8¾
Naraguta	26½	20½	—
Naraguta Durumi	16½	—	—
Naraguta Extended	4	8	16
Naraguta Karama	23	19¾	—
Naraguta Korot	9	12	—
Nigerian Consolidated	18	18	18
Offin River	8	8	7
Ribon Valley	21½	20	16
South Bukeru Areas	13	10	9
Tin Fields	6½	—	7¾
Tin Properties	17	13	8
United Tin Areas	21	23	35
Yarde Kerri	10	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	April.	May.	June.
Anglo-Burma (Burma)	12½	9½	23
Aramayo Mines (Bolivia)	273	205	207
Bangrin (Siam)	48½	53¾	60
Berenguela (Bolivia)	—	—	—
Consolidated Tin Mines (Burma)	94	77	96
East Pool (Cornwall)	82½	82½	82½
Fabulosa (Bolivia)	158	112¼	127
Geevor (Cornwall)	65	60	52
Jantar (Cornwall)	28½	29	—
Kagera (Uganda)	28	28	28
Northern Tavoy	54	45	40
Patino	1,602	1,527	1,289
Polhigey (Cornwall)	26	23½	31
San Finx (Spain)	30¾*	35*	—
Siamese Tin (Siam)	122½	146½	131½
South Crofty (Cornwall)	62½	64½	65
Tavoy Tin (Burma)	20	20	25
Theindaw (Burma)	10	10	8
Tongkah Harbour (Siam)	62	67	93
Toyo (Japan)	—	—	52½
Wheal Kitty (Cornwall)	38½	40	38½
Zaaiplaats	35	34⅓	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		May.	June.
Broken Hill South	Tons lead conc.	5,188	5,837
	Tons zinc conc.	4,775	5,721
Burma Corporation	Tons refined lead	6,420	6,420
	Oz. refined silver	607,645	609,934
Bwana M'Kubwa	Tons copper oxide	546	560
Electrolytic Zinc	Tons zinc	4,283	4,259
Indian Copper	Tons copper	224	247
Messina	Tons copper	641	651
Mount Lyell	Tons concentrates	3,872†	—
Namaqua	Tons copper	175	142
North Broken Hill	Tons lead conc.	7,140	6,670
	Tons zinc conc.	6,260	6,260
Poderosa	Tons copper ore	784	784
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,635	1,632
San Francisco Mexico	Tons lead conc.	4,050	4,124
	Tons zinc conc.	3,639	3,624
Sulphide Corporation	Tons lead conc.	1,912*	—
	Tons zinc conc.	2,467*	—
Tetiuhe	Tons lead conc.	1,129	983
	Tons zinc conc.	2,330	2,354
Union Minière	Tons copper	9,500	—
Zinc Corporation	Tons lead conc.	5,034	4,999
	Tons zinc conc.	4,327	4,967

* Four weeks to May 17.
† Four weeks to June 18.

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

		April.	May.
Iron Ore	Tons	456,048	459,329
Manganese Ore	Tons	18,583	13,813
Iron and Steel	Tons	234,806	233,725
Copper and Iron Pyrites	Tons	26,967	33,955
Copper Ore, Matte, and Prec.	Tons	3,164	3,951
Copper Metal	Tons	12,290	13,364
Tin Concentrate	Tons	8,178	8,471
Tin Metal	Tons	1,521	1,020
Lead Pig and Sheet	Tons	30,924	27,925
Zinc (Spelter)	Tons	10,491	13,493
Zinc Sheets, etc.	Tons	2,820	2,182
Aluminium	Tons	2,352	1,489
Mercury	Lb.	114,622	26,111
Zinc Oxide	Tons	906	1,370
White Lead	Cwt.	11,874	16,753
Red and Orange Lead	Cwt.	4,746	4,023
Barytes, ground	Cwt.	37,396	47,194
Asbestos	Tons	1,916	2,844
Boron Minerals	Tons	956	772
Borax	Cwt.	12,929	14,609
Basic Slag	Tons	4,663	1,206
Superphosphates	Tons	21,427	7,509
Phosphate of Lime	Tons	32,747	42,842
Mica	Tons	275	324
Sulphur	Tons	9,801	10,278
Nitrate of Soda	Cwt.	83,338	64,497
Potash Salts	Cwt.	341,092	172,192
Petroleum : Crude	Gallons	30,407,223	53,210,183
Lamp Oil	Gallons	15,182,215	17,245,295
Motor Spirit	Gallons	75,237,607	106,857,354
Lubricating Oil	Gallons	10,196,042	9,685,996
Gas Oil	Gallons	6,228,706	19,945,772
Fuel Oil	Gallons	43,514,258	36,186,621
Asphalt and Bitumen	Tons	21,113	23,021
Paraffin Wax	Cwt.	120,531	82,079
Turpentine	Cwt.	13,589	19,422

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES

In Tons.

	April.	May.	June.
Anglo-Ecuadorian	17,416	17,168	16,127
Apex Trinidad	35,770	33,400	36,690
Attock	2,282	2,115	2,287
British Burmah	5,198	5,268	4,969
British Controlled	32,083	30,034	33,431
Kern Mex	789	712	667
Kern River (Cal.)	3,951	3,401	2,545
Kern Romana	2,998	2,813	2,663
Kern Trinidad	6,410	5,990	5,011
Lobitos	29,229	28,023	29,431
Phœnix	44,544	53,156	57,727
St. Helen's Petroleum	5,495	5,780	5,700
Steaua Romana	73,310	82,410	80,420
Tampico	3,202	3,131	2,942
Trinidad Leaseholds	32,550	31,550	28,200
Venezuelan Consolidated	1,495	1,626	1,588

QUOTATIONS OF OIL COMPANIES SHARES

Denomination of Shares £1 unless otherwise noted.

	June 10, 1930.	July 10, 1930.
	£ s. d.	£ s. d.
Anglo-American	3 14 9	3 14 9
Anglo-Ecuadorian	16 3	15 6
Anglo-Egyptian B.	2 5 0	2 5 0
Anglo-Persian 1st Pref.	1 6 5	1 7 6
,, ,, Ord.	4 5 0	4 2 6
Apex Trinidad (5s.)	1 1 0	1 0 0
Attock	1 5 0	1 0 0
British Burmah (6s.)	5 3	5 3
British Controlled ($5)	4 0	3 0
Burmah Oil	4 7 6	4 5 0
Kern River, Cal. (10s.)	5 0	4 3
Lobitos, Peru	2 1 3	1 15 0
Mexican Eagle, Ord. (4 pesos)	12 3	13 3
,, ,, 8% Pref. (4 pesos)	12 3	13 3
Phœnix, Roumania	11 6	11 6
Royal Dutch (100 fl.)	32 11 3	32 12 0
Shell Transport, Ord.	4 13 9	4 13 9
,, ,, 5% Pref. (£10)	10 0 0	10 0 0
Steaua Romana	8 9	8 0
Trinidad Leaseholds	2 17 6	2 7 6
United British of Trinidad (6s. 8d.)	6 6	5 9
V.O.C. Holding	2 16 3	2 6 0

PRICES OF CHEMICALS. July 10.

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

		£ s. d.
Acetic Acid, 40%	per cwt.	16 6
,, 80%	,,	1 16 6
,, Glacial	per ton	66 0 0
Alum	,,	8 10 0
Alumina, Sulphate, 17 to 18%	,,	6 15 0
Ammonia, Anhydrous	per lb.	10
,, 0·880 solution	per ton	15 10 0
,, Carbonate	,,	27 10 0
,, Nitrate	,,	24 0 0
,, Phosphate	,,	40 0 0
,, Sulphate, 20·6% N.	,,	10 2 0
Antimony, Tartar Emetic	per lb.	10½
,, Sulphide, Golden	,,	7
Arsenic, White	per ton	15 15 0
Barium, Carbonate, 94%	,,	5 10 0
,, Chloride	,,	10 0 0
,, Sulphate, 94%	,,	5 0 0
Benzol, standard motor	per gal.	1 7
Bleaching Powder, 35% Cl.	per ton	6 15 0
Borax	,,	13 10 0
Boric Acid	,,	22 0 0
Calcium Chloride	,,	5 5 0
Carbolic Acid, crude 60%	per gal.	2 2
,, ,, crystallized, 40°	per lb.	7½
Carbon Disulphide	per ton	24 0 0
Citric Acid	per lb.	1 6½
Copper Sulphate	per ton	23 0 0
Cresylic Acid, 97–99%	per gal.	1 11
Creosote Oil (f.o.b. in Bulk)	,,	4½
Hydrofluoric Acid	per lb.	6
Iodine	per oz.	1 0
Iron, Nitrate	per ton	6 0 0
,, Sulphate	,,	1 15 0
Lead, Acetate, white	,,	35 15 0
,, Nitrate	,,	29 10 0
,, Oxide, Litharge	,,	33 10 0
,, White	,,	42 0 0
Lime, Acetate, brown	,,	7 5 0
,, ,, grey, 80%	,,	14 10 0
Magnesite, Calcined	,,	9 10 0
Magnesium, Chloride	,,	6 15 0
,, Sulphate, comml.	,,	3 15 0
Methylated Spirit 64° Industrial	per gal.	1 9
Nitric Acid, 80° Tw.	per ton	21 0 0
Oxalic Acid	per cwt.	1 12 0
Phosphoric Acid	per ton	29 15 0
Pine Oil	,,	42 10 0
Potassium Bichromate	per lb.	4½
,, Carbonate	per ton	24 10 0
,, Chlorate	,,	26 5 0
,, Chloride 80%	,,	9 15 0
,, Ethyl Xanthate	per 1,016 kilos	55 15 0
,, Hydrate (Caustic) 90%	per ton	29 10 0
,, Nitrate, refined	,,	21 0 0
,, Permanganate	per lb.	5½
,, Prussiate, Yellow	,,	6½
,, ,, Red	,,	1 8
,, Sulphate, 90%	per ton	11 0 0
Sodium Acetate	,,	19 0 0
,, Arsenate, 45%	,,	26 0 0
,, Bicarbonate	,,	10 10 0
,, Bichromate	per lb.	3½
,, Carbonate (Soda Ash)	per ton	6 0 0
,, ,, (Crystals)	,,	5 5 0
,, Chlorate	,,	24 10 0
,, Cyanide, 100% N.CN basis	per lb.	7
,, Ethyl Xanthate	per 1,016 kilos	53 5 0
,, Hydrate, 76%	per ton	14 10 0
,, Hyposulphite	,,	9 0 0
,, Nitrate, 96%	,,	10 2 0
,, Phosphate, comml.	per cwt.	11 0
,, Prussiate	per lb.	4½
,, Silicate	per ton	9 10 0
,, ,, (liquid, 140° Tw.)	,,	8 10 0
,, Sulphate (Glauber's Salt)	,,	2 12 6
,, ,, (Salt-cake)	,,	2 15 0
,, Sulphide	,,	10 0 0
,, Sulphite, pure	per cwt.	14 0
Sulphur, Flowers	per ton	11 10 0
,, Roll	,,	10 0 0
Sulphuric Acid, 168° Tw.	,,	5 7 6
,, ,, free from Arsenic, 144° Tw.	,,	4 0 0
Superphosphate of Lime, 33%	,,	3 9 0
Tartaric Acid	per lb.	1 1
Turpentine	per ton	40 5 0
Tin Crystals	per lb.	1 2
Titanous Chloride	,,	10
Zinc Chloride	per ton	12 0 0
Zinc Dust	,,	27 10 0
Zinc Oxide	,,	39 0 0
Zinc Sulphate	,,	10 10 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	June 10, 1930. £ s. d.	July 10, 1930. £ s. d.
SOUTH AFRICA:		
Brakpan	2 13 6	2 15 0
City Deep	5 9	6 0
Consolidated Main Reef	14 9	17 6
Crown Mines (10s.)	3 7 0	3 11 3
Daggafontein	1 5 0	1 4 0
Durban Roodepoort Deep	10 6	11 3
East Geduld	1 19 0	1 19 6
East Rand Proprietary (10s.)	10 3	9 9
Geduld	3 10 0	3 14 6
Geldenhuis Deep	6 3	7 0
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.)	1 15 0	1 12 6
Langlaagte Estate	1 3 0	1 4 6
Meyer & Charlton	13 0	13 0
Modderfontein New (10s.)	4 1 6	3 17 6
Modderfontein B (5s.)	14 3	14 0
Modderfontein Deep (5s.)	1 5 3	1 5 0
Modderfontein East	1 7 6	1 6 0
New State Areas	1 16 0	1 16 3
Nourse	8 6	10 0
Randfontein	6 6	8 0
Robinson Deep A (1s.)	16 0	16 3
" " B	8 6	9 0
Rose Deep	4 3	4 6
Simmer & Jack (2s. 6d.)	2 4	2 6
Springs	3 6 0	3 7 6
Sub Nigel (10s.)	2 3 0	2 15 0
Van Ryn	8 0	7 6
Van Ryn Deep	1 12 0	1 11 3
Village Deep	2 9	3 0
West Rand Consolidated (10s.)	6 3	6 0
West Springs	13 0	14 0
Witwatersrand (Knight's)	9 0	10 0
Witwatersrand Deep	3 0	4 6
RHODESIA:		
Cam and Motor	1 1 3	18 0
Gaika	3 6	3 9
Globe and Phœnix (5s.)	13 9	13 6
Lonely Reef	18 9	1 0 0
Mayfair	10 0	10 0
Rezende	1 4 6	1 1 3
Shamva	1 6	1 0
Sherwood Starr	18 0	1 0 0
GOLD COAST.		
Ashanti (4s.)	1 9 6	1 8 6
Taquah and Abosso (5s.)	2 6	2 6
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 6	2 3
Great Boulder Propriet'y (2s.), W.A.	1 6	1 3
Lake View and Star (4s.), W.A.	12 6	12 3
Sons of Gwalia, W.A.	1 9	1 3
South Kalgurli (10s.), W.A.	13 0	12 9
Waihi (5s.), N.Z.	13 0	13 0
Wiluna Gold, W.A.	18 0	17 9
INDIA:		
Balaghat (10s.)	2 0	2 6
Champion Reef (10s.)	7 6	6 9
Mysore (10s.)	10 3	10 3
Nundydroog (10s.)	15 3	15 3
Ooregum (10s.)	5 3	5 0
AMERICA:		
Camp Bird (2s.), Colorado	9	9
Exploration (10s.)	5 9	5 0
Frontino and Bolivia, Colombia	11 6	11 6
Mexican Corporation, Mexico	5 0	5 0
Mexico Mines of El Oro, Mexico	1 9	2 3
Panama Corporation	15 9	15 0
St. John del Rey, Brazil	16 9	16 9
Santa Gertrudis, Mexico	8 9	8 9
Selukwe (2s. 6d.), British Columbia	3 3	3 0
MISCELLANEOUS:		
Chosen, Korea	4 9	5 0
Edie (5s.), New Guinea	15 0	10 6
Lena Goldfields, Russia	3	3

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	15 0	13 3
Esperanza Copper, Spain	1 1 6	1 1 6
Indian (2s.)	1 6	1 3
Loangwa (5s.), Rhodesia	4 6	3 9
Luiri (5s.), Rhodesia	4 0	3 3
Messina (5s.), Transvaal	12 3	10 6
Mount Lyell, Tasmania	1 7 9	1 2 6
Namaqua (£2), Cape Province	11 6	7 6
N'Changa, Rhodesia	2 17 6	2 12 6
Rhodesia-Katanga	1 9 0	1 3 9
Rio Tinto (£5), Spain	36 10 6	34 12 6
Roan Antelope (5s.), Rhodesia	1 6 3	1 1 3
Tanganyika, Congo and Rhodesia	1 16 3	1 12 0
Tharsis (£2), Spain	4 0 0	4 0 0

LEAD-ZINC:	June 10, 1930. £ s. d.	July 10, 1930. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	9 6	9 6
Broken Hill Proprietary, N.S.W.	18 6	15 6
Broken Hill North, N.S.W.	2 17 6	2 7 6
Broken Hill South, N.S.W.	2 0 0	1 13 9
Burma Corporation (10 rupees)	11 3	10 9
Electrolytic Zinc Pref., Tasmania	1 3 9	1 2 6
Mount Isa, Queensland	18 9	16 3
Rhodesia Broken Hill (5s.)	2 3	2 6
San Francisco (10s.), Mexico	17 3	14 6
Sulphide Corporation (15s.), N.S.W.	12 0	10 6
ditto, Pref.	18 9	17 0
Zinc Corporation (10s.), N.S.W.	1 5 3	1 1 3
ditto, Pref.	3 6 3	2 18 9

TIN:		
Aramayo Mines (25 fr.), Bolivia	1 7 6	1 2 6
Associated Tin (5s.), Nigeria	5 9	5 6
Ayer Hitam	13 6	11 0
Bangrin, Siam	13 9	12 6
Bisichi (10s.), Nigeria	7 6	6 3
Chenderiang, Malay	1 6	1 6
Consolidated Tin Mines of Burma	4 6	3 9
East Pool (5s.), Cornwall	9	9
Ex-Lands Nigeria (2s.), Nigeria	1 6	1 6
Geevor (10s.), Cornwall	3 9	3 6
Gopeng, Malaya	2 3 9	1 18 9
Hongkong	17 6	15 3
Idris (5s.), Malaya	7 6	6 6
Ipoh Dredging (10s.), Malay	1 0 0	17 0
Kaduna Prospectors (5s.), Nigeria	7 9	5 6
Kaduna Syndicate (5s.), Nigeria	12 6	12 6
Kamunting (5s.), Malay	7 9	6 0
Kepong, Malay	1 0 0	17 6
Kinta, Malay	10 9	9 9
Kinta Kellas, Malay	7 3	6 6
Kramat Pulai, Malay	1 7 6	1 3 9
Labat, Malay	6 0	6 9
Malayan Tin Dredging (5s.)	1 1 0	18 3
Naraguta, Nigeria	8 9	8 9
Nigerian Base Metals (5s.)	1 3	1 0
Pahang Consolidated (5s.), Malay	7 6	7 6
Penawat ($1), Malay	1 3	1 3
Pengkalen (5s.), Malay	13 0	12 6
Petaling (2s. 4d.), Malay	11 3	10 0
Rambutan, Malay	10 0	8 9
Renong Dredging, Malay	1 0 0	1 0 0
Siamese Tin (5s.), Siam	10 0	9 9
South Crofty (5s.), Cornwall	3 3	2 6
Southern Malayan	13 3	11 6
Southern Perak, Malay	1 18 9	1 13 9
Southern Tronoh (5s.), Malay	7 6	6 6
Sungei Besi (5s.), Malay	9 9	8 3
Sungei Kinta, Malay	18 0	14 0
Tanjong (5s.), Malay	10 6	9 9
Tavoy (4s.), Burma	5 9	5 3
Tekka, Malay	19 9	17 6
Tekka Taiping, Malay	19 0	16 3
Temengor, Malay	8 9	6 3
Toyo (10s.), Japan	3 9	3 6
Tronoh (5s.), Malay	17 3	15 6

DIAMONDS:		
Consol. African Selection Trust (5s.)	1 7 6	1 3 9
Consolidated of S.W.A.	10 3	8 0
De Beers Deferred (£2 10s.)	7 15 0	7 5 0
Jaggersfontein	1 16 3	1 12 6
Premier Preferred (5s.)	4 5 0	4 5 0

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

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

ELECTROSTATIC PRECIPITATION OF BURNER GAS IMPURITIES

The purification of burner gases by means of electrostatic precipitators was dealt with by J. J. Healy in a paper presented at the June meeting of the American Institute of Chemical Engineers held in Detroit. The author stated that the results presented in his paper are a summary of a year's experience with Cottrell precipitators in the purification of pyrites burner gases for making contact acid with a platinum catalyst. Inasmuch as these Cottrells are of a different design from that customarily employed in America, the data are of interest for comparison with the performance of precipitators of the usual type.

An installation of these Cottrells seemed the best solution for the dust problem arising from the burning of lead-bearing ore. This ore contains approximately 1% lead and consequently the burner gas contained, in addition to acid mist and iron-oxide dust, an appreciable quantity of lead fume. Acid mist can be readily removed by a coke filter. The combination of iron-oxide dust and acid mist can he handled by installing a dust collector of some sort and a preliminary filter of relatively coarse coke to prevent the fouling of the main coke box by any uncollected dust. This dust necessitates cleaning the preliminary filter at intervals, which is something of a nuisance. This nuisance is greatly aggravated by the presence of lead fume in the burner gases, inasmuch as the very fine nature of the lead sulphate particles brings about a much more rapid rate of increase in resistance of the preliminary filter than would a similar amount of iron-oxide dust. Obviously in this case, any type of mist remover which has a large amount of unpacked area and is as efficient as the coke filter would be a more desirable installation. The Cottrell readily meets the first specification and is guaranteed to meet the second. A Cottrell dust precipitator also was installed as it was understood that its efficiency was higher on this particular kind of dust than that of any other type of collector.

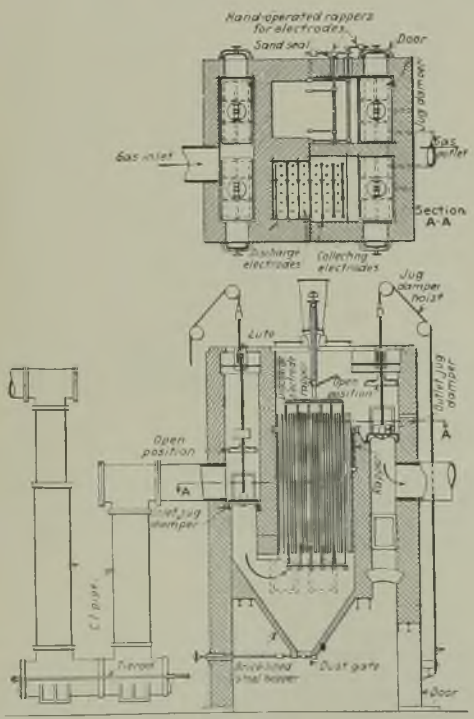


FIG. 1.
(Reproduced from *Chemical and Metallurgical Engineering.*)

Precipitator units were designed and installed, their construction being shown in the accompanying drawings, Figs. 1 and 2. It will be seen that the dust collector or hot Cottrell (Fig. 1) consists of a brick chamber having two separate compartments in parallel. Each compartment has seven collecting electrodes arranged parallel to one another. Each electrode is 10 × 4 ft., and is a two-mesh screen of 10-gauge steel wire riveted to a steel frame. Between the collecting electrodes are the precipitating electrodes made of chrome steel wire. The whole system is hung from a frame and is cleaned by rapping the frame, the resulting vibration dislodging the dust. Dampers are arranged so that either chamber can be cut out for cleaning or repairs. Dust drops into the hopper-like portion of the shell and is then dumped through a gate valve into a lower compartment. This Cottrell is operated at 50,000 volts.

TABLE I. —PERFORMANCE OF HOT COTTRELLS.

	Total Dust		$PbSO_4$		Fe_2O_3	
	Mg. per cu. ft.	Lb. per day.	Mg. per cu. ft.	Lb. per day.	Mg. per cu. ft.	Lb. per day.
In	453	2.960	96	620	357	2,340
Precipitated	419	2,720	82	529	337	2,191
Out	34	240	14	91	20	149
Efficiency (per cent)	91·8		85·4		93·7	

Temperature in, 820° F.; temperature out, 655° F.; pressure drop, 0·2 in. H_2O; gas volume, 2,060 c.f.m. at 0° C. and 760 mm.

The mist-collecting unit or cold Cottrell (Fig. 2) consists of three parallel pairs of lead chambers arranged in series. These are separated electrically, the first pair, or primary unit, on one circuit, and the last two pairs, or secondary units, on another. Collecting electrodes here are lead sheets, five in each primary chamber, and six in the secondaries. Precipitating electrodes are lead-covered copper wires. The whole precipitating system is suspended as in the hot Cottrells. It will be noticed that the electrodes in the primary precipitators are arranged at right angles to the gas stream while those in the secondary units are parallel to it. This was intended to bring about better distribution of

the gas, but has in fact resulted in channelling, most of the gas rising through the ducts on the outlet side. It is expected that an increase in the area of the holes in the distribution plate on the inlet side will correct this.

It will be noted that the conductor enters each chamber through an oil seal and that dry purified burner gas is introduced into the seal chamber from a bypass on the pressure side of the blower to prevent short-circuiting due to condensation of moisture.

resistance. Both primary and secondary units are operated at 63,000 volts, and the secondary circuit is so arranged that any shut-down will stop the blower and prevent any impure gas from being introduced into the converters.

There is, of course, a transformer station, not shown in the figures. Each unit has its own switchboard, rectifier and transformer. The daily cleaning of the apparatus requires that the units be interchangeable, and a suitable arrangement of

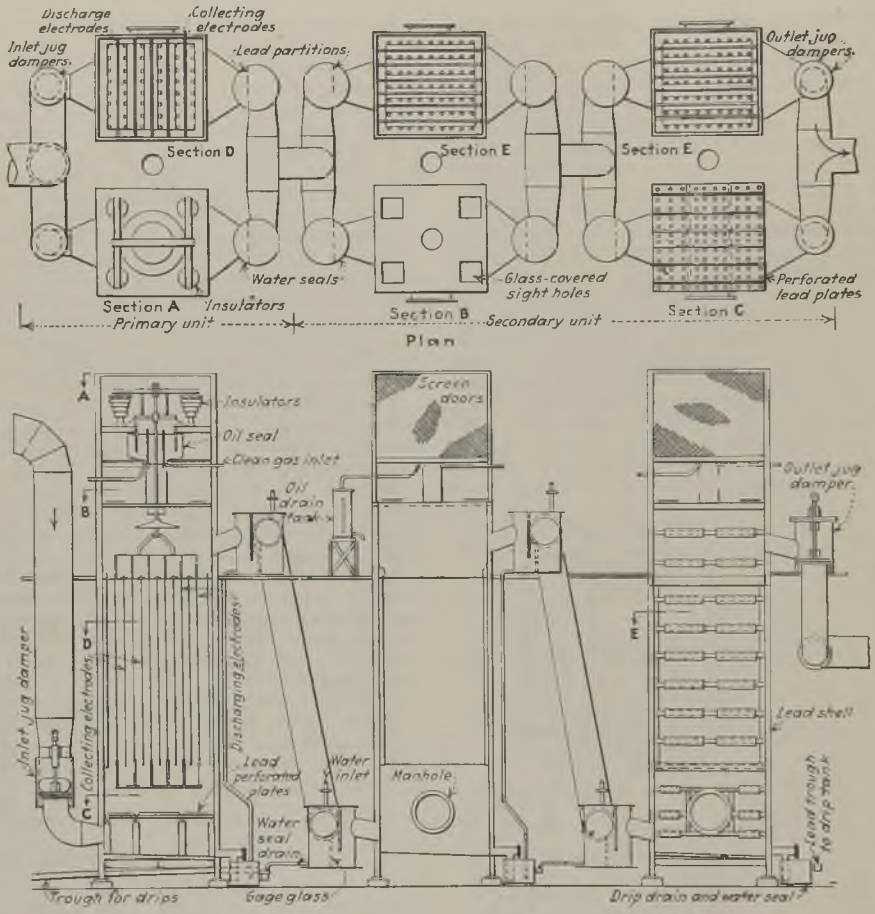


FIG. 2.
(Reproduced from *Chemical and Metallurgical Engineering*.)

All units have a water seal at inlet and outlet so that any unit or combination of units may be cut out of the system. This is a very desirable arrangement, but in this case the seals were not large enough, and the centre baffles have been cut out to lower

TABLE II.—PERFORMANCE OF COLD COTTRELLS

	H_2SO_4 Mg. per cu. ft.	As_2O_3 Mg. per cu. ft.	$PbSO_4$ Mg. per cu. ft.
In	168·0	5·2	7·75
Out, primary	4·2	0·13	0·019
Out, secondary No. 1	0·23	0·0023	0·0031
Out, secondary No. 2	0·015	0·00013	0·0007

Temperature in, 85° F., temperature out, 70 to 95° F.; pressure drop, 1 in. H_2O; gas volume, 2,800 c.f.m. at 0° C. and 760 mm.

bus-bars is provided so that all three can be operated on one rectifier and transformer.

Power consumption of the three units is approximately as follows :—

Hot Cottrell	3·5 kw.
Cold Cottrell, primary	0·8 kw.
Cold Cottrell, secondary	3·2 kw.

Performance of both hot and cold Cottrells is shown in Tables I and II. These results were obtained on a unit burning 28 tons of ore per day to a gas containing 10% SO_2. Table III shows the composition of the weak acid precipitated from the mist.

It is of interest in connexion with the hot Cottrell

results that this unit was operated for a short time on a lead-free ore and an efficiency of 99% obtained.

TABLE III.—COMPOSITION OF COTTRELL DRIPS.

	H_2SO_4 Deg. Bé.	As_2O_3 Mg. per C.C.	$PbSO_4$ Mg. per C.C.
Primary	20·0	9·0	7·1
Secondary No. 1	11·5	4·5	0·05
Secondary No. 2	*	0·05	0·000

* 10 Mg. H_2SO_4 per c.c.

The results given in the tables may be low, as there are indications that some of the lead shown in the exit test is in the vapour phase in the collector. It may be remarked that there is some leakage of air around the sand lutes on top, the drop in gas strength amounting to about 0·5%, that is, from 10 to about 9·5%.

Results of the cold Cottrell tests bring out several interesting points. First, the equivalent sulphur content of the drip has never amounted to more than 3% of the sulphur burned, or no more than is normally obtained on a sulphur unit. Gas analyses to check this result have indicated that, at the outside, not more than 5% of the sulphur burned is converted to SO_3. Past experience with pyrites had led the author to expect a conversion of 7% of the sulphur ahead of the Cottrells. Another point of interest is the fact that the acidity of the condensate from a long flue, connecting the Cottrells and the dry tower, is normally equivalent to an H_2SO_4 concentration of 0·5 to 1·0 mg. per cu. ft. in the gas. The mist test, of course, shows nothing like this, as the difference between the exit of the Cottrells and the entrance of the dry tower is only 0·01 mg. H_2SO_4 per cubic foot. The reason for the discrepancy, which must be due either to error in analysis or to oxidation in the flue, has never been determined satisfactorily. In any case, the result is as good as that obtained on a coke filter by the same method.

Somewhat the same situation exists in regard to the arsenic results. The arsenic content entering the dry tower is about one-half that shown at the exit to the Cottrells. Although the arsenic in the flue condensate checks this difference quite well, the final arsenic concentration is at the upper limit of what is the permissible arsenic content of burner gases for use with a platinum mass. However, there have been no signs of poisoning, and, what is more conclusive, the gases are in no worse condition than those leaving a coke filter, when tested by the same method. Incidentally, the method used to obtain the above results is the ordinary method for determining acid mist by filtering the gas through asbestos and leaching. Arsenic is determined by the Gutzeit method on the leach liquor. This method gives results that are twice those obtained by the customary method of bubbling the gas through water.

Exit temperature variation shown is due to the difference between atmospheric temperatures in winter and summer. No air leaks in the cold Cottrells have been noticed.

THE PRESIDIO MINE, TEXAS

Technical Publication No. 334 of the American Institute of Mining and Metallurgical Engineers contains a paper by Messrs. V. D. Howbert and R. Bosustow on "Mining Methods and Costs at Presidio Mine of the American Metal Co. of Texas." Extracts from this paper are given here.

The mine is situated 20 miles by road north of the Mexican border, in semi-desert surroundings typical of this general section of the United States and the adjoining part of Mexico. All supplies are hauled in by truck from Marfa, a station on the Southern Pacific Railway, under contract. The concentrates and precipitates produced by the mill are carried by the same trucks to Marfa, from whence they are shipped, respectively, to the El Paso and Selby plants.

GEOLOGY.—The area covers a series of sedimentary rocks, principally limestones, shales and sandstones, with a few beds of conglomerate. Of these, the lowest formation seen on the property is a limestone, of Permian age, locally called the Cibolo limestone. The upper part of the Cibolo formation is the ore-bearing rock of the mine. It is separated from the overlying Lower Cretaceous rocks, principally bedded limestones, shales and sandstones, by an unconformity. Overlying the Cretaceous rocks on the neighbouring hills is a series of eruptive flows. The sedimentary rocks have been folded into a rather gentle dome and in the vicinity of the main workings dip to south-east or south at from 6° to 20°, with an average of about 12°. The whole area is extensively fractured and faulted.

The ore-bodies are rather flat mantos which lie at several horizons in the Cibolo limestone, in general parallel to the bedding of that rock. They are typical replacement bodies and they are very irregular in trend. The ore is siliceous and consists largely of quartz, with some calcite, dolomite, and iron oxide, containing silver as chloride and as the sulphide, argentite. Spots of argentiferous galena, and occasionally lead carbonate and sulphate, occur through the ore. Where the bodies contain much iron oxide the ore is comparatively soft; such ore is not continuous and is mixed with harder sections of siliceous ore, or with beds of unreplaced limestone, or blocks of coarsely crystallized calcite. The limestone foot and hanging walls are usually irregular. On the sides of the bodies there are no sharp walls, the mineralization gradually grading out into silicified honeycombed limestone, and then into unreplaced, comparatively unaltered, country rock. The limestone in the vicinity of the ore-bodies is generally finely recrystallized and occasionally shows spots of pinkish colour and some dendritic manganese stain.

The principal ore deposits developed by the present operating company are the Bore-Hole and Tranquelino bodies. The former was developed by driving in the favourable limestone horizon in the practically virgin country west of the Mina Grande fault. The Tranquelino is the extension of an old body of the same name, south-west of a fault up to which it had been mined many years ago. The latter ore has now been developed westward to the Mina Grande fault, and prospecting is being carried on to find its further extension in the downthrown block to the west. Thus, the principal present mining operations are concentrated in a section south and west of the old south-western part of the mine, at a vertical depth of from 200 to 500 ft. below the surface. It is felt that the source of a large part of the mineralization of the old mine lies to the west or the south-west, and accordingly it is believed that further important extensions will be developed in that direction.

The ore, though soft in spots, stands up well and no timbering is required to support it during development. The hanging wall, though only dipping ordinarily about 12°, is of firm, uniform, thick-bedded limestone. It needs no support, even over large stopes. The sizes of the stopes vary considerably as the bodies are followed. Locally they may widen out laterally along some zone of fissures, and the thickness also varies from place to place, and in one body may be, along its margins, only from 2 to 6 ft., while in the centre or at points where it shows a tendency to make up, locally, into a higher horizon in the limestone, it may reach a thickness of 40 ft.

So far there has been no variation in the character of the ore with depth, and the deepest parts of the mine contain essentially oxidized ore such as existed at the outcrop. The values are erratically distributed through the ore, and many sections of the bodies develop with a grade that is not marginal under present conditions; on the other hand, some parts of the stopes yield ore of much above average grade in silver, probably due to concentrations from leaching and reprecipitation during the oxidation of the deposits.

In addition to several major faults, there are many minor faults and slips, which have a few feet of throw, as well as many open fissures of varying strikes, often as much as 1 ft. wide, and water courses. In the stopes these fissures tend to confuse the extensions of bodies, cause additional irregularities in them, break up the ore with consequent lowering in grade, and thus add to the difficulties of stoping.

Methods of Prospecting and Exploration.—Although all of the upper 200 ft. of the Cibolo limestone apparently is favourable for ore deposition, the principal bodies have occurred in the lower part of this section, and at the present time prospecting is being practically confined to the search for new bodies, and for extensions of those formerly mined, in this lower part of the favourable horizon. Wherever possible the prospect drives and cross-cuts are driven at an elevation that would be somewhat below any probable ore occurrence, not only to make these workings available for ore extraction, but to take advantage of the discovery of secondary iron oxide, which may have leached down into fissures below any ore-body. In looking for extensions the probable future trends are predicted as closely as possible, but the irregular nature of the deposits often causes a body to make an unexpected turn, which renders useless some cross-cut that was driven in the anticipated direction. Accordingly, it has been found impracticable to drive too far ahead of the known position of any body, and expense is saved by prospecting for extensions only short distances in advance. At all times a reasonable amount of exploration is carried out in the most favourable horizon, in the hope of picking up new bodies not directly connected with those now known. Roughly, it can be said that the present operating company has developed about 9·0 tons of ore per foot of exploration and development work.

Diamond drilling, as an exploration method, has been tried but found to be unsatisfactory, owing to the number of open fissures and to the broken-up nature of much of the ground by the extensive minor faulting and fracturing. The water was usually lost before a hole had been driven far, and lost bits caused an excessive carbon cost. It is possible that diamond drilling might be used as a method of prospecting with short holes from stopes in the search for near-by branches, or for overlying or underlying mantos, especially in the less fractured blocks of ground, without excessive difficulty or cost, and will probably be tried on such work at some time in the future.

Sampling and Estimating Tonnage.—The description of the irregularity of the mineralization indicates how difficult it is to block out or estimate tonnage far in advance. Formerly an effort was made to trace the extensions of the bodies for some distance, and to sill them out at definite intervals to determine cross-section and grade, but on account of the irregular nature of the trends, walls and distributions of values, it was found that this entailed excessive cost, caused much unproductive work and was not worth while. It has now been decided that the ore cannot be blocked out indefinitely ahead of stoping requirements, although effort is made to open up the ground in advance by drive and rises for a reasonable distance. Pilot faces are carried in the stopes to ascertain trends as far as possible.

Once a certain body has been mined for some distance, it is possible to estimate what it is likely to produce over a given length of extension. It is also found that its average grade is fairly uniform wherever opened. It is thus possible to make a rough estimate as to tonnage and grade to be expected over a section that has been indicated by several scattered rises.

Development.—The mine has two main working shafts. The first, called the South shaft, was sunk in the western part of the mine in the neighbourhood of the outcrops, and is that through which most of the ore is now being hoisted; it is 400 ft. deep, with principal levels at intervals of 100 ft. At present most of the work is being done on the third and fourth levels. The fourth level opened up the new country west of the Mina Grande fault, and will continue to be the main tramming level in the western part of the mine; from it an interior shaft has been sunk to 500 ft. and a fifth level is being driven to prospect for any branch from the Bore-Hole body on the dip of the beds to the south.

The second shaft from the surface, the East shaft, lies 1,850 ft. north-east from the South shaft, and is 700 ft. deep. The upper terminal of the aerial tram connecting the mine with the mill, which lies in a valley one mile to the east, is near the collar of the East shaft, and is connected to the South shaft by surface narrow-gauge tracks over which 2-ton side-dump cars are hauled by gasoline locomotives.

Shafts and Winzes.—The interior shaft from the fourth to the fifth level was recently completed.

Drives and Cross-cuts.—All drives and cross-cuts are driven approximately 5 by 7 ft. on contract. No timber is required. Light Leyner-type drifters are employed, with standard column and arm, using 1 in. hollow round steel. The usual round is of "toe-cut" type, with 18 holes. The crew consists of a contractor, helper, and one or two mucker-trammers, depending on distance from the shaft. The explosive is 40% gelatine powder.

Rises.—Rises in limestone or ore are driven 5 by 6 ft., also on contract. No timber is required, with the exception of staging, and access is gained to the back by rope or cable ladder. Hand-rotated stopers, with $\frac{7}{8}$ in. hexagon steel, are employed. The usual round uses a toe-cut with about 15 holes. For short

rises the driller can handle the work, but after a height of 30 ft. is reached a helper is also used; one to two mucker-trammers, depending on distance to shaft, are needed. The explosive is 40% gelatine powder.

Open-stope Mining.—Inasmuch as the limestone back stands without support over an opening of any size, open stopes are used throughout the mine. The ore is mined selectively, in order to keep it above a minimum grade, and pillars are left when the ore becomes non-marginal. Rough sorting is done in the stopes, the waste being placed in parts where it will not interfere with operations.

In developing and mining an ore-body an extraction drive is run below a body, which is then tapped by rises at approximately 50 ft. intervals. Where the level is at an excessive distance below the part of the stope being worked, a sublevel is driven, to which the ore is dropped and then trammed to a main rise from the haulage drive. Where a body is over 25 ft. above a level, it is not economical to space rises closer than at 50 ft. intervals; this ordinarily necessitates more or less wheelbarrow work in moving the ore from a stope face to the nearest rise. Thus the flat nature of the deposit entails a relatively high mucking cost per ton. Due to the irregularity of the ore, each part of a body is of necessity worked in accordance with the existing conditions, and no standard procedure can be laid down. Were it not for the advisability of mining the ore to a maximum grade, with corresponding comparatively expensive selective mining and increased necessity for careful supervision, which is more than justified by increased return, it would be possible to lower materially the existing mining cost. In other words, a considerable tonnage of material running 6 to 10 oz. silver exists in the bodies, and if it were economically possible also to mine ore of this grade, possibly lowering the average mine grade to around 14 or 15 oz., it would be possible to cut down present costs about 20%. To illustrate the advantage to be derived from careful selective mining, the 160,000 tons mined in three years of operation by the present company have averaged 22 oz. silver, as compared to an average grade of 11 oz. for the last 500,000 tons mined prior to 1926.

Where the stope is over 8 to 10 ft. thick (high) ordinarily the section next the hanging wall is mined ahead, leaving a bench from which to drill; the bench is later broken as the cut is carried forward. The use of scrapers has been given careful consideration and trial underground; but on account of the irregular nature of the stope floors, as well as the comparatively small size of individual working faces and the frequent changes in direction of the commercial ore, it does not appear that scrapers would reduce the cost of handling ore in the stopes sufficiently to justify the expenditure for equipment.

Underground Transport.—Ore is trammed by hand in 1 ton end-dump cars from the chutes in the extraction drives to pockets at the South shaft. This shaft, prior to operations of the present company, was practically abandoned; work had been concentrated for some years in the eastern part of the workings around the two-compartment, well equipped East shaft. The South shaft has been equipped to pull all ore and waste, hoisting being done with a small efficient electric hoist handling a 0·7 ton bucket without guides. This may appear to be rather a small installation to handle the tonnage, but it has proved capable of hoisting 250 tons of combined ore and waste on two shifts at a reasonable cost. Men are not handled in this shaft; they either walk down to work through the gently inclined stopes, or are lowered through the East shaft.

Table I

Summary of Costs during Year 1929 *at Presidio Mine*

Tons Ore Hoisted during Period, 54,524.[1]

	Underground Costs per Ton Ore Hoisted.							
Work Performed.	Labour.	Super-vision.	Com-pressed Air, Drills and Steel.	Power Cost.	Explo-sives.	Tim-ber.	Other Supplies.	Total.
Development								
In ore	$0·026	—	$0·007	—	$0·008	—	$0·002	$0·043
In rock	0·733	—	0·160	—	0·109	—	0·020	1·022
Mining	1·442	$0·146	0·430	—	0·177	$0·025	0·056	2·276
Transport (underground)	0·435	—	—	$0·049	—	—	0·049	0·533
General underground expense								
Total	2·636	0·146	0·597	0·049	0·294	0·025	0·127	3·874
Surface expense (directly applicable to underground operation)	0·077	—	—	—	—	—	0·050	0·127
Total	$2·713	$0·146	$0·597	$0·049	$0·294	$0·025	$0·177	$4·001

[1] Tonnage does not include waste sorted out on surface.

Percentage of Extraction.—Due to selective mining, less than 75% of a body is broken as ore, the remainder being left as pillars and along the sides of the stope. There is practically no dilution with waste from the walls; the waste and low-grade ore sorted out, both underground and on the surface, come from inclusions in the bodies. It is estimated that 6% of the material broken is discarded underground as waste. Sorting at the shaft collar rejects as waste at the present time about 10% of the ore hoisted; this is a greater proportion than was formerly sorted out, and although it increases somewhat the cost per ton the expense is well justified.

Wages and Contract System.—All work underground, excepting pipe work, track work, timbering and supervision, is done on a contract basis. Contracts are figured more or less on the basis of day's pay in the district, as follows: $4

TABLE 2

Summary of Costs during 1929 *at Presidio Mine in Units of Labour, Power and Supplies* [1]

Tons Ore Mined and Hoisted, 54,524.

	Development.	Mining (Stoping)	Total.
Labour (man-hours per ton)			
Breaking (drilling and blasting)	0·41	1·28	1·69
Mucking	0·52	1·46	1·98
Tramming	0·26	0·74	1·00
Hoisting	—	—	0·37
Supervision	—	—	0·14
General	—	—	0·59
Total labour underground	1·19	3·48	5·77
Average tons per man per shift (underground)	—	—	1·39
Average tons per man-shift on surface properly chargeable to underground operation	—	—	17·83
Average tons per man-shift (total mine)	—	—	1·29
Labour, per cent of total cost	19·40	53·92	73·32
Power and Supplies			
Explosives (lb. per ton) 40 per cent gelatin	0·82	1·18	2·00
Total power (h.p.-hr. per ton)	5·43	17·51	23·70
Air compression	4·78	14·99	19·77
Hoisting	0·65	2·52	3·17
Lighting	—	—	0·53
Miscellaneous	—	—	0·23
Other supplies in per cent. of total supplies and power	10·14	30·26	40·40
Power, supplies and sundries, per cent. of total cost	7·61	19·07	26·68
Per cent of total cost	27·00	73·00	100·00

[1] All per-ton figures are based on total tonnage of ore mined and hoisted, not including waste sorted out on surface.

for machinemen; $3 for muckers and trammers. The contractor is paid a fixed price per unit of work, and is charged for powder, caps, fuse, and carbide. The men working for the contractor are paid by him through the company.

The prices paid on stope contracts vary greatly according to the conditions; they include delivery of ore into shaft pockets. An average price would be about $1.50 per ton.

The prices paid in limestone drives, cross-cuts, and rises average $7 per foot; this also includes tramming of waste to shaft.

All work is measured and paid for twice each month. In some cases a bonus is given to the contractor for footage above a certain minimum. All underground labour is Mexican.

At times considerable "buscon" work is carried out in old stopes. This includes mining small bodies with a grade above average. Payment to the buscon contractor is made at a predetermined amount per oz. silver per ton by assay. Sometimes this is on a sliding scale to encourage mining the ore clean.

VENTILATION.—No artificial ventilation is necessary in any part of the mine.

POWER PLANT, TRAMWAY AND CRUSHING PLANT.—The power requirements of mine and mill are supplied by separate power plants. The mine plant consists of three De La Vergne oil engines, two of twin-cylinder and one of single-cylinder type, totalling 340 h.p. rated capacity. These engines drive three air compressors, delivering a total of 1,350 cu. ft. of free air per minute, a 90-kw., 440-volt a.c. generator, and several minor pieces of equipment. Power costs for 1929 averaged $0.0154 per horsepower-hour.

The aerial cableway connecting the mine to the mill is of the double-rope type, 1 mile long. Buckets hold 825 lb. of ore. Tramway costs are not included in the direct mine costs, which are given in Tables 1 to 3. Before January, 1929, the coarse crushing of the ore was done above the upper tramway

TABLE 3

Detail of Costs during 1929 *at Presidio Mine in Units of Labour, Power and Supplies*

Rising and Cross-cutting in Untimbered Excavation 5 by 7 ft. in Uniform, Hard, Tough Limestone

Labour (man-hours per foot)	
Breaking (drilling and blasting)	3·35
Mucking	4·46
Tramming	2·23
Total labour	10·04
Feet per 8-hr. shift	2·39
Feet per man-shift	0·80
Power and supplies (per foot)	
Explosives (lb. per foot)	7·59
Total power (h.p.-hr. per foot)	50·40
Other supplies	$1·01
Labour, per cent of total cost	72·13
Power, supplies, and sundries, per cent of total cost	27·87

TABLE 4

Total Operating Costs at Presidio Mine, Including Tramway, Crusher, Mill, and General Charges

	1927.	1928.	1929.
Tonnage mined	48,429	57,441	54,524
Direct mine cost	$3·57	$3·50	$4·00 [1]
Direct tramway cost	0·17	0·20	0·11
Direct crusher cost	0·20	0·16	0·14
Direct mill cost	1·92	2·07	1·86
General charges	1·31	1·33	1·47
Total operating cost per ton	$7·17	$7·26	$7·58

[1] Includes surface motor haulage.

terminal bins. A new plant doing both the coarse and fine crushing is now in operation below the lower tramway terminal at the mill. Crusher costs, also, are not included in the direct mine costs.

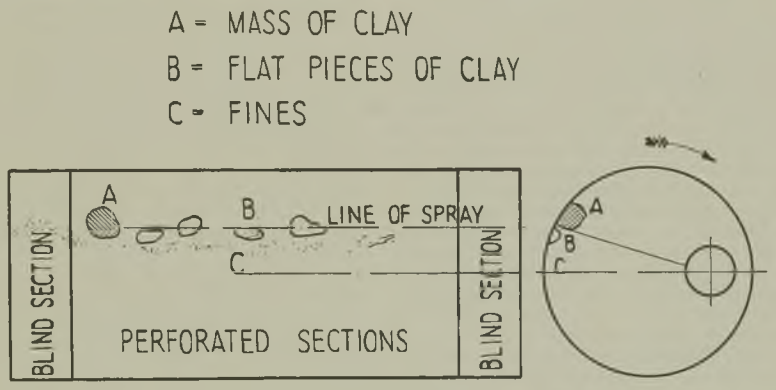
SAFETY.—Because of the relatively flat stopes and the substantial character of their walls, open stopes are employed with a very low accident rate. As far as available records go, there have been only three deaths due to underground accidents in the last 30 years of operation.

COSTS.—Tables 1, 2, and 3 show mine costs and efficiencies, and Table 4 gives total operating costs, including mine, tramway, crusher, mill and general charges.

DREDGE SCREENING

At a meeting of the Malayan Tin Dredging, Mining and Research Association, held on March 26 last, some notes on dredge screening were read by O. B. Williams, of Southern Malayan Tin Dredging, Ltd. Mr. Williams said that the work of the screen is to discard as much waste material as possible and to send the valuable material on for further treatment. Thus the screen functions roughly as a classifier of waste material from valuable and in many cases this function is carried further, an enlargement of the diameter of the screen hole in the later sections of the screen being adopted so that the material saved is itself classified. The object of this is to prevent the loss of values (which have not passed through previously) over the end of the screen, the larger hole permitting more material to come through. In some cases it is maintained that this classification into fine and coarse is an advantage in itself, apart from the safeguard it supplies against screen losses, but it might be asked if this classification is necessary. If the screen is to be used as a classifier, it should be followed by "classified concentration," that is—the jigs fed from the top end where the openings are small should run at higher speeds and with less stroke than those fed from the lower end where the holes are larger. This practice undoubtedly should be adopted where really coarse tin is associated with fine tin, but such cases are rare, generally the tin being of such quality of size as to make a distinction unwarranted, necessitating, as it would, special settings of speed and stroke for each type instead of one common to all with consequent simplification of operation and control. To say that the screen perforations when treating average material should be the same throughout may appear revolutionary but a case in favour of such a theory can be stated.

In the average wash the ratio of the diameter of the tin particle to the diameter of the sand particle is comparatively large. The size of the screen perforations is decided from an examination of the material obtained from the bore-holes or pits. If it is considered that a screen opening of ¼ in. diameter is sufficient to allow the free passage of the largest particle of tin together with a certain proportion of sand of larger diameter, it is difficult to see why this opening should be increased at a later stage, if the screen is of the correct capacity and the disintegration of the material by the wash water is carried out efficiently. It is often said that the larger opening is necessary as an insurance against possible loss of values over the end of the screen. With clay present or on occasions when patches of coarse tin are encountered of larger diameter than the average, losses above normal will occur, even with an enlarged opening, but under average conditions with a screen of correct capacity and efficient washing only normal losses should be shown. By "normal" is inferred losses which must be expected even when the screen is operating at its highest efficiency.



FIGS. 1 AND 2.

It has been stated recently in Malaya that large losses are made in the screen, and that more pressure water should be used. Before increasing the pressure water, however, the screen capacity should be examined, and a decision made as to whether the pressure water is being used efficiently.

Taking capacity first, it may be said that other things being equal the greater the slope the greater the capacity of any screen. With a large slope the velocity of travel down the screen is increased with consequent thinner bed of material, more grains coming into direct contact with the screen openings than with lesser slopes, slower travel and a thick bed. Hence not only is the capacity increased but also the efficiency. Therefore the losses from the screen may be due in some part to too small a slope resulting in a thick bed. In some cases, it is the practice to place angle iron ribs in the screen to retard the travel, with the object of keeping the material longer in the screen. From the above it appears that such a practice is of doubtful value

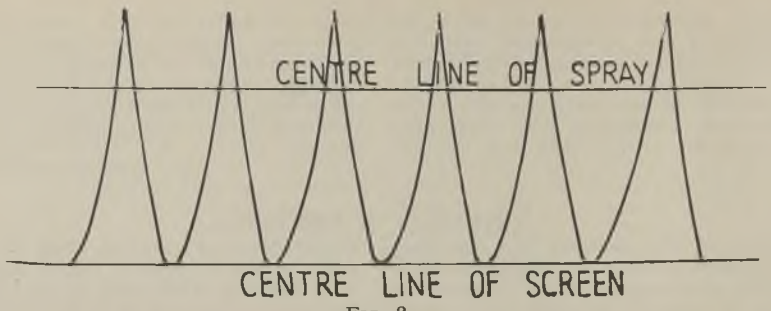


Fig. 3.

as it must result in reducing the velocity and giving a thicker bed, followed by a drop in the screening efficiency.

Turning to the pressure water from the sparge pipe, this is used to wash the feed through the screen perforations keeping these latter clear and also to some extent to disintegrate the material. The pressure can only be increased in two ways. (1) By reducing the jet or nozzle opening, which will result in a needle-like spray of very little use. (2) By increasing the quantity of water. It is weight of blow which is required and this will be attained by this method. Before adopting either method it must be remembered that any additional water is detrimental at a later stage, in fact, the present quantities used are too large for efficient work on the machines which follow unless some dewatering system is placed between the screen and the jig. Many people are apt to look on the matter from a "unit" point of view, and instead of considering what effect anything they do in the screen may have on the jigs, the screen is considered by itself and the jig similarly. The operations should be examined as a whole, one machine as far as possible being the servant of the other.

Returning to the question as to whether more water and greater pressure are required or whether those available are being used efficiently, it can be said that the travel of the material through the screen is peculiar, the path taken varying with the class of material, some materials lying comparatively inert in the bottom of the screen swaying gently from side to side, while others are carried with the peripheral velocity of the screen some distance up the side and then slip back again. At the same time both classes are travelling down the screen with a velocity greater or less varying directly with the slope.

Observations have been made of the travel of the feed through the screen on one of the dredges of the Southern Perak Dredging Co., and the results show the difficulty of deciding the best method of application of the sparge pipe water. The feed coming through at one time could be divided into the following three rough groups:—

1. Masses of clay of size equal to anything from half a 9 cu. ft. bucket to a whole bucket size.
2. Flat slabs of clay roughly 1 ft. to 2 ft. long by 9 in. wide and 2 in. thick due to the bucket skimming the bottom.
3. Fines from the marble size down with a few odd lumps of clay the size of a tennis ball.

The sparge pipe water impinged on the screen about 1 ft. 6 in. up the side of the screen measured on the chord. The feed behaved as follows :—The large masses of clay rushed down the drop-chute

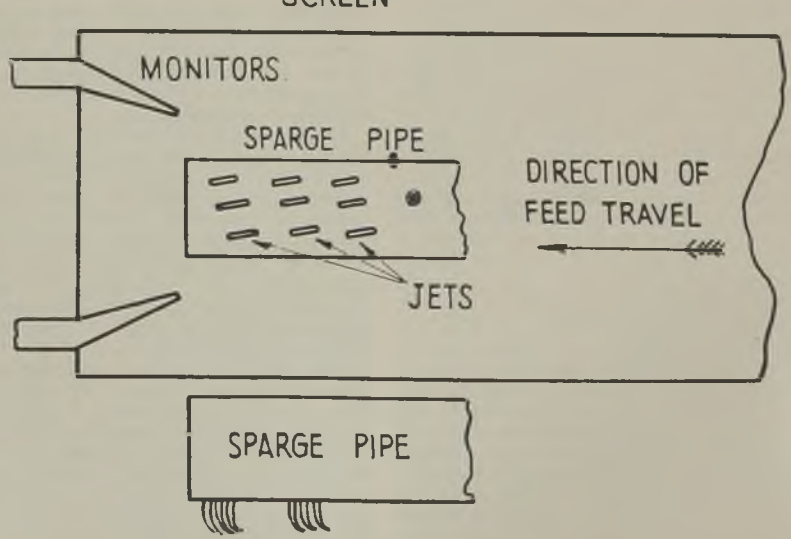


Fig. 4.

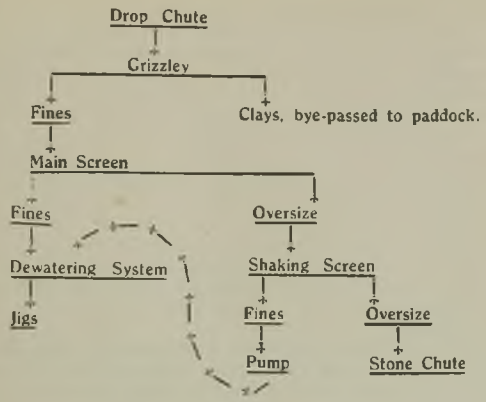


FIG. 5.

into the screen, sliding down the centre barely in the lower edge of the spray. This rush pushed everything before it and carried on for one-third of the distance down the screen when the peripheral velocity of the screen gradually retarded the drive down and the mass started to sway backwards and forwards through the spray. From this point the masses of clay rode on the top edge of the feed bank and swayed about in the bottom pushing everything aside. Below this the flat pieces are lifted by the peripheral velocity up the side of the screen into the line of spray and travel along that line, below again, swaying in the bottom, are the fines which rarely enter the zone of spray. (Figure 1.)

At times, when there is no clay present and only some cemented material and fines, the fines still keep to the bottom of the screen and scarcely enter the zone of spray. This is due to the fact that the spray, when it impinges on the screen, rushes down to the bottom, this flood of water being sufficient to equalize the throw up the screen of this fine material, due to peripheral velocity of the screen. At first glance this may appear to be wrong, as the path taken by the feed coming over the blind section of the screen end will appear to be in the line of the spray, and so it is, but it is only so when coming over this blind section where no spray water washes against it. Once free from the rush of water the peripheral velocity has full play and the feed is lifted into a line which if produced would enter the line of spray. (Figure 2.)

Returning to the clays, the path of travel of the masses through the screen was roughly checked as follows :—The second lowest perforated lining plate was projecting at the junction with the lowest section. The light shining on this wet edge gave a shining line in the screen easily seen from the end, and a piece of clay could be noted passing this point. The distance from the edge to the end of the screen was 18 ft. Using a stop watch the time taken by masses of clay to travel this distance was taken, the average time being 22 seconds. Also the number of times in that distance the masses swayed up and down were taken and averaged 12, and the extent of this upward movement measured on the chord was 2 ft. 6 in. It is thus possible roughly to set out the path of travel over this distance. The upward movement is fairly steep whereas the downward one was on the slant with a slight pause at the bottom. This is shown in Figure 3.

From the above it will be seen how difficult it is to obtain efficient washing and disintegrating, and a sparge pipe with jets in a straight line running parallel with the longer axis does not appear to be efficient. One dredge in Malaya has jets in " banks " of three pointing up and slightly across the screen and also two monitors—one on either side—at the end pointing up the screen. (Figure 4.) This makes a welter of water and seems to have a good washing and disintegrating effect on most types of feed, though it does not prove that throwing pulp into waves and splashes is going to assist screening. Another dredge has the jets pivoted to point in any direction, operated from outside. This would give good results for a constant type of feed, but where it varies from time to time it is doubtful if the labour employed pays sufficient attention to it.

In conclusion it can be said that the evolution of an efficient washing system and prevention of screen losses will not be found in merely increasing the pressure, but only in a careful study of each individual problem. It must first be ascertained correctly what the losses are, and then determined whether these losses are economically justified, that is, whether any attempt to reduce them would be so costly as to offset any gain in value. The following suggestions are made :—(*a*) The large masses of clay should be bye-passed before entering the screen, and dumped overboard if containing no values. This would require a much a larger drop-chute in all dimensions, and necessitate some loss of head. (*b*) The screen should have the same diameter perforations throughout, as much waste material being discarded as possible, and the sparge pipe nozzles should be in " banks " of three pointing up the screen, and set at a slight angle to the longer axis of the sparge pipe. (*c*) If losses over the discharge end occur, they will be caused by coarse grains of tin being entrapped with the coarse sand and stones, or by the smaller small lumps of clay picking up coarse tin on their passage through the screen, though this latter type of loss would not be very large in all probability. (*d*) The discharge could be passed over a shaking screen, the fines and coarse tin being sent to a pump and thence to the dewatering system and the jigs, the coarse material passing on to the stone chute. Should the clays, however, contain a considerable percentage of tin, it may pay to install a high speed puddler at the end of the main screen followed by the shaking screen.

The flow-sheets suggested are shown in Figs. 5 and 6.

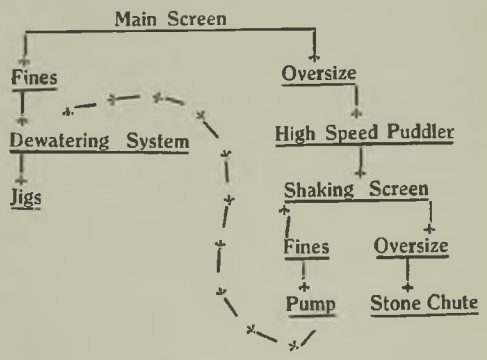


FIG. 6.

FLOTATION OF WILUNA ANTIMONIAL ORE

The sulphide ore of the West Lode, Wiluna Gold Mines, contains varying quantities of antimony, principally in the form of stibnite, which, when concentrated in the auriferous concentrate produced by flotation, introduces difficulties in the subsequent treatment of this product by roasting and cyanidation. Investigations on the possibilities and the methods of producing an auriferous concentrate containing less than the critical percentage of antimony, stated to be 1%, have been made by W. G. Clarke and B. H. Moore and their results are given in Bulletin 5 of the School of Mines of Western Australia.

The authors state that two possible methods of attack were available, namely :—

(1) Bulk flotation of the stibnite, pyrite and arsenopyrite, with the simultaneous production of a residue of low gold tenor, followed by selective flotation of the bulk concentrate for the production of—(a) an antimonial concentrate containing a minimum of gold and a maximum of antimony ; and (b) a high grade auriferous product containing a minimum of antimony and a maximum of gold ; this product would constitute the residue from the secondary treatment.

(2) Selective flotation of the ore itself, having for it object the production of—(a) a high grade antimonial concentrate low in gold, produced by flotation of the stibnite and prevention of flotation of the auriferous sulphides, either with or without the use of depressants ; (b) a high grade auriferous flotation concentrate produced by flotation of the arsenopyrite and pyrite after removal of the stibnite ; and (c) a residue of low tenor in gold and antimony.

In this ore the gold is associated for the most part with the arsenopyrite, while the stibnite is practically non-auriferous. Theoretically, therefore, on account of the great difference between the ease with which these two minerals can be floated, it would appear that no difficulty should be experienced in selectively floating these two constituents of the ore. This applies, of course, only to freshly mined, unoxidized minerals, but where partial oxidation of these minerals has taken place, the ease with which these minerals can be floated is greatly diminished owing to filming of the sulphides, so that production of a low grade gold residue is not readily attainable ; in addition, the presence of oxide of antimony, detected both in hand specimens and microscopically in a sample of table concentrates produced from flotation residues, prevents the production by flotation of a final residue low in antimony. The two samples forwarded from the mine for the tests had both been taken from surface dumps, and contained ore either from a partially oxidized zone of the lode or which had been exposed on the surface for a long period.

The results obtained from the first series of tests showed that selective flotations of ore offered better possibilities of success in the production of separate antimony and gold concentrates than selective flotation of a bulk concentrate. In the production of the bulk concentrate the use of potassium xanthate is essential in order to secure a satisfactory recovery of gold, and in any subsequent selective flotation of this concentrate it is impossible to avoid flotation of excessive amounts of gold in the antimonial concentrate owing to inability to eliminate the potassium xanthate by washing or to destroy its conditioning effect by the use of depressing agents without at the same time depressing the stibnite.

It was also found that in selective flotation of the ore, the use of depressants in the primary flotation was unnecessary, provided that no potassium xanthate was used. Consequently, the investigation has been continued on selective flotation of the ore without the use of depressants with the object of producing (a) an antimonial concentrate of low gold value, (b) a gold concentrate low in antimony, (c) a residue low in both gold and antimony.

As two hours' agitation with sodium sulphide before the secondary flotation produced a residue of lower gold value than had been obtained in any previous tests, it was decided to carry out a series of tests, using increasing amounts of sodium sulphide, and at the same time to determine the effect of grinding in (a) an atmosphere of air, (b) an atmosphere of carbon dioxide, (c) an atmosphere of producer gas.

In all subsequent tests in which the ore, after the primary (antimony) flotation, was agitated with sodium sulphide before carrying out the secondary (gold) flotation, a mechanical agitator was used, but no baffles were employed in the agitation tank so that the charge was subjected to a minimum of aeration during the agitation period. This course was adopted on account of the auriferous mineral, the arsenopyrite, being very susceptible to oxidation, and consequently aeration of the charge would tend to nullify the beneficial sulphidizing action of the sodium sulphide. The harmful effect of excessive aeration during the sulphidizing period was early apparent. Agitation with sodium sulphide was in all cases carried out in a thick pulp produced by decantation of the primary flotation residue, the decanted liquor being used for making up the feed for the secondary flotation to the required density.

The investigations showed that there would be no difficulty in satisfactorily eliminating the stibnite from the gold concentrate by a primary flotation without the use of pyrite depressing agents. At the same time, the partially oxidized condition of the ore, which has been indicated and conclusively proved by the results of the tests, prevented the production of final residues containing as small a proportion of the total gold and antimony as might be expected when dealing with a freshly mined, unoxidized sample of ore. The partially oxidized condition of the ore is indicated by the impossibility of removing in a primary and a secondary flotation more than about 70% of the antimony, although stibnite is one of the most easily flotable minerals, and also by the improvement in the concentration of the gold values by making use of the sulphidizing action of sodium sulphide subsequent to the primary (antimony) flotation and prior to the secondary (gold) flotation. Chemical tests also have shown that a considerable proportion of the total antimony is present in the ore in the form of oxides.

Owing to the tendency of carbon dioxide to assist the flotation of the gold-bearing sulphides, it was not considered advisable to use that gas in place of air for froth formation during the primary flotation.

The results of the work, so far as it has progressed, led the authors to the following conclusions :—

(1) *Ore containing massive stibnite.*—The stibnite when in massive form is low in gold values and could be successfully separated by hand picking.

(2) *Selective Flotation of Bulk Concentrate.*—The selective flotation of a bulk concentrate produced by the use of potassium xanthate as a conditioning agent did not appear practicable owing to the impossibility of (a) removing the potassium xanthate by washing, or (b) destroying the conditioning effect of the xanthate on the pyrite and arsenopyrite by the use of depressants without at the same time depressing the stibnite.

(3) *Selective Flotation of Ore.*—Any injurious effect produced by grinding the ore in air could be overcome by agitation with sodium sulphide prior to the secondary flotation. Owing to the samples being partially oxidized, agitation with sodium sulphide prior to the secondary flotation was beneficial, even after grinding in a neutral atmosphere. The usual reagents employed for depressing pyrite are also depressants of stibnite, but a suitable conditioning agent, such as potassium xanthate, is essential for the successful flotation of the pyrite and arsenopyrite in the Wiluna ore.

The stibnite can be successfully floated without the use of a conditioning agent, which thus enables the antimony to be separated from the gold-bearing sulphides by a primary flotation in which the use of pyrite depressants is neither necessary nor desirable.

Flotation in a 3 : 1 pulp gives results which compare favourably with tho e obtained when using a dilution of 5 : 1, fine grinding being necessary for the liberation of the stibnite from the gangue. The stibnite could be successfully floated after grinding with 0·06 lb. eucalyptus oil per ton of ore, but for successful flotation of the pyrite and arsenopyrite it was necessary that more oil be used, the whole of which was added during the grinding operation.

An elimination from the gold concentrates of 90%, and concentration of 60%, of the antimony content of the Wiluna ore could be obtained by a primary flotation with eucalyptus oil without the use of a conditioning agent. Finally, a recovery in the primary and secondary concentrates of 90% of the gold contents might be expected, provided that agitation with sodium sulphide preceded the secondary flotation.

Hydro-Metallurgy of Copper.—The *Monthly Bulletin* of the State College of Washington for April last contains the first progress report by A. E. Drucker and C. F. Floe on the laboratory development of an electro-hydrometallurgical process for copper flotation concentrates. The authors state that the field of application of the hydro-metallurgical processes for the recovery of metals from their ores has been rapidly expanded in the last few years. This has been partly due to the fact that the old methods of treatment could not be applied economically to the extraction of the metals from the more complex and lower grade ores, and partly to the increased knowledge of the chemical or wet processes. Great improvements in plant equipment have also aided materially in the advancement of this method of treatment.

Hydrometallurgical methods for the extraction of copper have been largely confined to the treatment of low-grade oxidized ores. Some experiments have been conducted in an effort to apply these methods to the treatment of high-grade copper sulphides, but in no case has it been used on a large commercial scale. In the Pacific Northwest, the abundance of cheap hydro-electric power offers every advantage for such a process as applied to simple sulphide copper ores (mill concentrate), and makes the possibilities for such treatment well worth consideration and investigation at this time. Selective flotation methods have certainly paved the way. The purpose of the publication of this work of the authors was to show the results of some preliminary tests conducted in their own laboratories, and if possible to stimulate further research along this line.

Some metallurgists have agreed that a hydro-metallurgical process for copper sulphides offers considerable possibilities, but only in a very few cases have the results of actual tests been published. P. Middleton, in 1919, published results but these were not entirely complete and he urged that the investigations be continued, since the process showed considerable promise. Others may have made investigations, but the writers had been able to find but very few actual results. Certainly the small amount of material published and available on this particular phase of hydro-metallurgy well warrants that further tests be conducted. W. E. Greenawalt, a recognized authority on copper hydro-metallurgy, has said that there is no difficulty in producing electrolytic copper direct from the ore or concentrate. The concentrate is preferred for the reason that the roasting and leaching installation is greatly cheapened, both in installation and operation. Hundreds of careful roasting tests have proved conclusively that from 70 to 80% of the copper can be made water soluble by careful roasting, and that a very high extraction of copper is obtainable by dilute acid leaching. The water soluble copper, on electrolysis to produce electrolytic copper, furnishes the acid, at no additional cost, to leach the copper from the ore which is not soluble in water. There is therefore, no acid expense in connection with the copper leaching and electrolysis. Careful tests, with a complete miniature plant, have proved that fully 1 4 pounds of copper can be deposited per kilowatt hour, with the simultaneous regeneration of all the acid required to leach the copper from the roasted ore or concentrate. The resulting electrolytic copper is as pure as that made anywhere.

The authors of the present work say that the application of a hydro-metallurgical process to sulphide copper concentrates will involve three steps ; roasting, leaching, and precipitation (electrolysis). The main problems to be worked out are :—

1. The proper conditions of roasting in order that the insoluble copper sulphides may be converted into a form that is soluble in the dilute acid solvent.

2. Keeping down the impurities of the electrolyte (mainly iron) in order that a pure deposit of copper can be efficiently made.

3. Avoiding an accumulation of an excessive amount of acid, due to the formation of water soluble copper sulphate in the roast.

4. Proper conditions of electrolysis.

5. Removing gold and silver values from the tailing, if there is a sufficient amount present to make it pay.

The experiments at the State College of Washington have been conducted on a small laboratory scale.

Ores Tested.—Two different types of ore were used in the tests : bornite from the Index Copper

Company, Index, Washington, and chalcopyrite from the Royal Development Company, Leavenworth, Washington. Tests on the former were performed first, and were designed to show the effect of roasting at various temperatures on the solubility of the iron and copper. Later tests on the chalcopyrite ore were for the purpose of determining the proper strength of leach solution, and for the production of a comparatively pure electrolyte from which the copper could be economically precipitated by electrolysis.

Conclusions.—The results of these laboratory tests so far as carried out indicate : First : That by roasting at approximately 600° C it is possible to convert 94% of the copper into a form that is soluble in less than 2% H_2SO_4. At the same time all but approximately 4% of the total iron is rendered insoluble. Second : That the remaining copper can be removed by leaching with a higher strength of acid so that a total extraction of 96 to 98% of the copper can be attained. Third : That the iron entering the leach solution can be largely precipitated, after neutralization by CuO in the calcine, and oxidation with manganese dioxide, or oxygen from the air, or both. Fourth : That a solution of copper sulphate of high purity can be obtained, from which the copper can be readily precipitated by electrolysis with a cathode efficiency of over 90%.

Therefore, from the results so far obtained the following method of treatment for flotation sulphide copper concentrate is suggested for the authors' next step of procedure with a laboratory continuous treatment plant.

1. Roasting the clean concentrate (— 100M) at 600° C. (50% water-soluble copper) in a multiple hearth roaster until all the sulphides are practically decomposed.

2. Leaching the copper with dilute sulphuric acid (1·5 to 2%) and producing a neutral solution of copper sulphate by using a double leaching system.

3. If necessary, further purification of this solution by proper air agitation in the presence of copper oxide.

4. Electrolysis of the solution and precipitation of the copper on copper starting-sheet cathodes, with the subsequent regeneration of the sulphuric acid solvent. The aim is to keep down the water-soluble ($CuSO_4$) copper to 50%, instead of 70 to 80% as some metallurgists have recommended, thereby preventing excessive amounts of regenerated H_2SO_4 acid which would be undesirable with the present method of procedure.

5. Use a portion of the regenerated acid to dissolve more copper, and by-passing the remainder in order to keep the acid content of the electrolyte down. If the amount by-passed for this purpose is excessive, the acidity may be reduced possibly by filtering through beds of limestone or calcium carbonate ; however, this will have to be proved by trial.

6. If necessary, agitating the tails from the above leach with the by-passed solution in order to remove a higher percentage of the copper.

7. Precipitation of the copper remaining in the by-pass after electrolysis on scrap iron, or by hydrogen sulphide, if the acidity is too high.

8. Converting the cement copper or copper sulphide precipitate thus formed into copper (CuO) oxide and returning it to the neutral-leach for purification.

9. Thoroughly washing the tailing, followed by cyanidation for the extraction of the gold and silver, if present in paying quantities.

The authors wish it to be expressly understood that the process as outlined by them is by no means a definite one. It is only the one which appears to be the most logical and feasible from the favourable small scale tests so far conducted in their laboratory. A small continuous plant may bring to light several changes which would alter the outline (flow-sheet) of this treatment considerably. The erection of such a plant as suggested by Greenawalt in the author's laboratory is the next step toward determining the adaptability and merits of the process. The comparative costs and the economics of the process must be carefully investigated. There is no better prospective field in metallurgy than with the hydro-metallurgical treatment and extraction of electrolytic copper from mill (flotation) copper sulphide concentrate. It is hoped that this work will encourage others to investigate the possibilities of this new field of metallurgy where the cost of producing electrolytic copper of high purity from flotation copper concentrate with hydro-electric power at $\frac{1}{3}$ to 1 cent per kilowatt hour should not be more than 1·5 to 3 cents per pound depending upon the scale of operations.

Treatment of Low-Grade Sulphide Ore from the Lake View and Star Mine.—A series of experiments on low-grade sulphide ore from the Lake View and Star Mine were conducted by W. G. Clarke and B. H. Moore to determine (1) the results obtainable by flotation in fresh water circuit ; (2) the extent to which free gold might be removed by means of corduroy strakes ; (3) the effect on the flotation results of—(a) non-removal of free gold, (b) removal of free gold by means of corduroy strakes prior to flotation.

At the same time it was decided to obtain a comparison of the efficiency of recovery of free gold by amalgamation and by means of corduroy strakes, as well as to investigate the subsequent roasting and cyanidation of the flotation concentrates. For the purpose of comparison, flotation in salt water was also carried out under otherwise similar conditions to those obtaining in the fresh water tests. The results of these tests are presented in Bulletin 5 of the School of Mines of Western Australia.

The conclusions drawn from the investigation are set out below.

(*a*) *Removal of Free Gold.*—Corduroy strakes concentration, Wilfley table concentration, copper plate amalgamation, and amalgamation during grinding appear to be of equal efficiency in removing the amalgamable gold. Concentration by means of corduroy strakes or on the Wilfley table produces an intermediate product which requires separate and special treatment to recover the free gold, namely, reconcentration, to reduce the bulk of the product to such an extent that the plant required for the final amalgamation treatment shall be reasonably small.

Copper plate amalgamation of the tube mill product is equally efficient and much more simple than corduroy strakes concentration, and, if used in conjunction with efficient mercury traps, there should be no danger of mercury or amalgam getting into the flotation circuit. Since the final rich corduroy concentrate would require to be amalgamated to recover the free gold, and the tailings from this treatment would be returned

to the treatment circuit, there is the same likelihood, if any, of mercury or amalgam getting into the circuit from this source as from the copper plate amalgamation of the ore. By placing the copper plates in a properly guarded enclosure to which only responsible officers have access, as it is presumed would be done with an installation of corduroy strakes, the risk of loss of gold would in each case be the same. For the same tonnage capacity the area of the enclosure required for a copper plate installation would be much less than that required for a corduroy strakes installation, with its accompanying appliances for reconcentration and for amalgamation of the final strakes concentrate.

(*b*) *Grinding and Flotation.* — Highly satisfactory and remarkably uniform results under varying conditions showed that this ore is particularly suitable for flotation. The fineness of grinding for the successful and economical application of flotation requires further investigation, but, apparently, it is not necessary to grind finer than −150 mesh. It is necessary that free gold should be removed by suitable means before flotation.

On the Lake View ore, flotation in a fresh-water pulp gives an extraction equally as good as that obtained in a salt-water pulp (5% NaCl). This has the advantage that the concentrate requires no washing before roasting. A flotation feed containing one part solids to three parts water gives as high an extraction as a more dilute pulp. A minimum quantity of flotation reagents is required, and it is not essential that these reagents be added to the tube-mill feed.

(*c*) *Roasting of Concentrates.*—No trouble should be experienced in roasting the flotation concentrates, provided that the temperature is kept low during the early stages of the roasting operation. Under these conditions there is no tendency for the ore to " ball " or dust, nor is there any loss of gold by volatilization.

(*d*) *Cyanidation of Roasted Concentrates.*—The product resulting from the conduct of roasting under the above conditions yields a high percentage extraction and a low grade residue by cyanidation, with or without preliminary washing of the roasted concentrates. Preliminary washing of the roasted concentrates results in a considerable reduction in the consumption of cyanide and lime in cyanidation, that is, 1·14 lb. KCN and 3·88 lb. CaO per ton roasted concentrates. Amalgamation of the roasted concentrates is not necessary. The value of the whole of the residues (flotation and cyanidation) from the amalgamation, flotation, roasting, and cyanidation of this ore should not exceed 0·8 dwt. gold per ton of original ore.

Inclined Top-Slicing.—The inclined top-slice stoping method used at a phosphate mine belonging to the Anaconda Copper Mining Company is described by E. M. Norris in the thirty-first annual report of the Inspector of Mines on the mining industry of Idaho for 1929. The writer states that the phosphate mines and milling plant of the Anaconda Copper Mining Co. are situated 9 miles north of Soda Springs, Idaho, at the town of Conda, which was built by the company to house its employees. A branch railroad connects with the main line of the Union Pacific Railroad at Soda Springs.

The phosphate deposits are of sedimentary origin, which have been folded and tilted at angles varying from 45° to 90° from the horizontal. Erosion of an anticlinal fold has produced an outcrop of the phosphate bed which can be traced by shallow depressions for many miles. The minable phosphate bed has a fairly uniform width of 7 ft. and is confined within soft phosphatic shales lying on top of limestone. The ore body and hanging wall are soft and will not stand without support for more than a few hours after opening. This, together with the fact that special care in mining is necessary to prevent contamination of the ore by wall rock, makes a difficult mining condition which has been solved by the use of an inclined top-slicing method of stoping.

The mine is opened by an adit or main haulage level, 9 ft. wide by 10 ft. 2 in. high inside of timber, and by main or transfer rises leading into it. The portal of this tunnel is adjacent to the milling plant. Three-compartment rises, spaced at 100 ft. intervals, are driven on the phosphate bed from the main and sub-haulage levels to the top of the ore or surface. Sublevels spaced at successive intervals of 150 ft. are then driven on the vein from these rises; these drives are small and almost entirely untimbered. Stoping is commenced by driving a 40° inclined drive (rise) along the top of the ore. The roof of this drive is supported by caps and posts, and a floor of 2 in. lumber is laid lengthwise on sills, which are 5½ ft. from centre to centre, across the bottom of the drift. The hanging-wall of the vein is supported by the posts with 2 in. lagging placed behind them. The incline of the stope rise (drive), together with the smooth floor, is sufficient to cause the broken rock from the headings to drop by gravity into the ore chute, from which it is loaded into 2 ton side-dump mine-cars and trammed by hand to the transfer rises leading into the main haulage level.

Two to four adjacent stopes are usually worked simultaneously and all of the ore is recovered, as the adjoining slices are connected by lagging off the vertical (top) end of the finished drift or slice. After the slice is completed, the roof of the drive is brought down on to the floor by blasting the supporting timbers. One to two holes are bored in each cap and post into which the powder is placed; the fuses are ignited by hand, and the entire slice shot at one time, thus forming a timbered mat on top of the floor, which then becomes the roof of the next slice. The whole procedure is then repeated for consecutive slices until the block of ore is worked out.

A production of about 13½ tons per man-shift is obtained, and the timber requirement is approximately 12 ft., board measure, per ton of ore.

SHORT NOTICES

Mining Methods in Michigan.—Mining methods and practice in the Michigan Copper mines are described by W. R. Crane in Bulletin 306 of the Bureau of Mines, Washington.

Drilling and Blasting.—In Bulletin 311 of the Bureau of Mines, Washington, E. D. Gardner gives the results of an investigation into drilling and blasting methods in metal mine drives and cross-cuts.

Compressed Air.—The *Journal* of the South African Institution of Engineers for June contains an article by S. Hunt on the " pressure drop " caused by the flow of compressed air in pipe lines, under commercial conditions.

Pneumatic Tools.—The selection, operation and maintenance of pneumatic tools is discussed by

L. D. Waymouth in the *Journal* of the South African Institution of Engineers for May.

Manganese Compounds.—The non-metallurgical applications of manganese compounds in industry are outlined in the *Chemical Trade Journal* for June 27.

Geophysical Prospecting.—In the *Proceedings* of the Australasian Institute of Mining and Metallurgy for March 31 C. T. Tennberg deals with modern prospecting on an industrial scale, while F. Rieber in *Mining and Metallurgy* for June discusses choice in geophysical methods.

Bore-Hole Surveying.—At a meeting of the North-Eastern Institute of Mining Engineers held on June 21, J. T. Whetton discussed the surveying of bore-holes.

Northern Rhodesian Copper.—The ores of the Northern Rhodesian copper belt are described by Dr. A. M. Bateman in *Economic Geology* for June–July.

Katanga.—"Le Katanga, Pays du Cuivre" is the title of a brochure issued by the Union Minière du Haut-Katanga.

Panamint Silver District, California.—The geology of the Panamint silver district, California, is described by F. MacMurphy in *Economic Geology* for June–July.

RECENT PATENTS PUBLISHED

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

4,809 of 1928 (328,362). International Nickel Co. and P. D. Merica, New York. Tarnish-resistant, rust-proof and non-corrodible alloys of nickel-chromium-iron capable of being worked.

29,760 of 1928 (328,240). P. Gredt, Luxemburg. Granules, or finely divided ores obtained from minette are reduced in a furnace which comprises a smelting furnace in combination with a preheating and reducing furnace.

601 of 1929 (328,940). B. A. Miller, Pennsylvania. An inclined sluice, with a converging bottom and baffles which extend across one side and the apex of the sluice only, permits concentrates to move progressively forward at the apex of the flow, undisturbed by agitation above.

2,307 of 1929 (328,283). I. L. Bramwell, C. N. H. Holmes and the Birtley Iron Co., Birtley, Durham. Apparatus for the pneumatic separation of minerals.

2,873 of 1929 (328,564). A. R. Powell, Amersham, E. C. Deering, Barnet and Johnson Matthey and Co., London. Platinum ores or concentrates containing chromite are given a preliminary oxidizing treatment, as for instance by roasting with litharge, prior to smelting by the ordinary lead blast-furnace methods.

4,288 of 1929 (311,267). Deutsche Edelstahlwerke A.-G., Bochum, Germany. Chromium-Tungsten-Vanadium-Carbon Steels for use as rifling steels.

4,336 of 1929 (328,696). F. L. Duffield, London. Sulphide ores containing nickel, iron or other metals are granulated, partially burnt, then mixed with salt and further roasted, whereby the metals are converted into volatile chlorides which are withdrawn from the furnace and condensed.

18,673 of 1929 (329,543). Orkla Grube-Aktiebolog, Trondhjem, Norway. Solutions containing cobalt or other metals and which are rich in iron, such as those obtained after the precipitation of cement copper from roasted pyrite leach liquors, are oxidized by using an alkali chlorate prior to precipitating the iron. This method prevents oxidation of the cobalt compounds.

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.

American Petroleum Refining. By H. S. Bell. 2nd edition. Cloth, octavo, 631 pages, illustrated. Price 31s. 6d. London: Constable and Co.

The Measurement of Hydrogen Ion Concentration. By Dr. J. Grant. Cloth, octavo, 159 pages, illustrated. Price 9s. London: Longmans, Green and Co.

Geology and Minerals of Quebec. By Dr. W. L. Goodwin. Cloth, pocket-size, 346 pages, illustrated. Gardenvale, Quebec: Industrial and Educational Publishing Co.

Petroleum in Roumania. By M. Pizanty. Paper backs, 100 pages, illustrated. Price $2 Bucharest: Monitcur du Pétrole Roumain.

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By Dr. J. W. Mellor. Vol. X. S, Se. Cloth, octavo, 958 pages, illustrated. Price 63s. London: Longmans, Green and Co.

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The Mineral Industry of the Far East. By Boris B. Torgasheff. Cloth, octavo, 510 pages, illustrated. Price 40s. Shanghai: Chali Company.

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Seismometer, Auswertung der Diagramme. By Dr. H. P. Berlage, jr. **Geologie der Erdbeben.** By Dr. A. Sieberg. Handbuch der Geophysik, Vol. IV, Part 2. Paper covers, pages 299–686, illustrated. Subscription-price: 30 marks. Berlin: Gebrüder Borntraeger.

The Geology of the Alnwick District. By R. G. Carruthers, G. A. Burnet, and W. Anderson. Paper boards, 138 pages, illustrated. Price 3s. Memoir of the Geological Survey of England and Wales. London: H.M. Stationery Office.

The Effect of the Rate of Cooling on the Structure and Constitution of Steel. By Dr. J. M. Robertson. Safety in Mines Research Board Paper No. 59. Paper backs, 57 pages, illustrated. Price 2s. London: H. M. Stationery Office.

The Reactivity of Coke. 3. The Influence of Iron Compounds. Fuel Research Technical Paper No. 25. Paper covers, vii + 42 pages, illustrated. Price 9d. London: H.M. Stationery Office.

Fluor Spar Deposits of Canada. By M. E. Wilson. Paper covers, 97 pages, illustrated. Price 20 cents. Economic Geology Series of the Geological Survey of Canada, No. 6. Ottawa: Department of Mines.

Lardeau Map Area, British Columbia. By J. F. Walker and M. F. Bancroft. Mineral Deposits by H. C. Gunning. Paper backs, 142 pages, illustrated, with map. Memoir 161 of the Geological Survey of Canada. Ottawa: Department of Mines.

New Brunswick, Canada. Its Natural. Resources and Development. By L. O. THOMAS Paper backs, 166 pages, illustrated, with map. Ottawa: Department of the Interior.

Annual Geological Report of the Somaliland Agricultural and Geological Department for 1929. Paper boards, 12 pages, with map. Price 2s. London: The Crown Agents for the Colonies.

Year Book of the American Bureau of Metal Statistics, 1929. Paper backs, quarto, 117 pages. Price $2. New York: American Bureau of Metal Statistics.

Annual Report of the Director of the U.S. Bureau of Mines for the year ended June 30, 1929. Paper covers, 63 pages. Price 10 cents. Washington: Superintendent of Documents.

Advanced Mine Rescue Training. Part 2.—Instructions in Methods of Sampling and in the Use of the Bureau of Mines Portable Orsat Apparatus for Analysing Mine Gases. By W. P. YANT and L. B. BERGER. Paper covers, 89 pages, illustrated. Price 20 cents. Washington: The Superintendent of Documents.

Annual Report of the Mining Industry of Idaho, 1929. By STEWART CAMPBELL. Paper backs, 300 pages, illustrated. Boise, Idaho: The Inspector of Mines.

Mining in California. January, 1930. By WALTER W. BRADLEY. Paper backs, 88 pages, illustrated. San Francisco: Division of Mines.

Mineral Resources of the United States, 1928. Part I, pp. 7–20, Platinum and Allied Metals, by V. C. HEIKES. Part II, pp. 41–53, Slate, by O. BOWLES and A. T. COONS; pp. 55–65, Sulphur and Pyrites, by R. H. RIDGWAY.

How the Stock Market Really Works. By W. COLLIN BROOKS. Cloth, octavo, 150 pages. Price 5s. London: Sir Isaac Pitman and Sons.

COMPANY REPORTS

Transvaal Gold Mining Estates.—During the year ended March 31 last 199,010 tons of ore was milled for 58,809 oz. of gold. The revenue was £250,268, equal to 29s. 0·6d. per ton and the working expenses totalled £220,015, or 25s. 6·5d. per ton. The working profit was £30,254 and dividends at the rate 5% absorbed £28,599. The ore reserves at the end of the financial year totalled 607,777 tons averaging 7·7 dwt. per ton, as compared with 509,362 tons, averaging 7·5 dwt. at the end of the previous year.

Taquah and Abosso Mines.—The report for the year ended March 31 last shows that 100,790 tons of ore was treated during the year, the value of the 39,676 oz. of gold recovered being £168,558, as compared with 41,046 oz., worth £174,384, in the previous year. The ore reserves at the end of the financial year were estimated to be 234,572 tons, averaging 35s. 1d. per ton over 52 in., as compared with 261,206, worth 34s. 6d. per ton, at the end of the previous year. There was a profit for the year of £2,760 after writing off £10,000 for depreciation of plant.

Naraguta Karama Areas.—This company was formed in 1926 to acquire alluvial tin properties in Northern Nigeria. The report for the year 1929 shows that during the year 311 tons of tin concentrates was recovered, as compared with 284½ tons in 1928. The average price per ton realized for the ore was £117 as compared with £133 in the previous year. The profit for the year was £4,377 which has been carried forward. Of the year's product 220½ tons came from the Sho areas.

South Kalgurli Consolidated.—The report of this company for the year ended March 31, 1930, shows that 98,254 tons of ore was treated of a gross value of £190,623. The profit for the year was £31,716 and dividends amounting to 2s. 6d. per share absorbed £31,251. The ore-reserves at the end of the financial year were estimated to be 218,000 tons, averaging 8·95 dwt., blocked out, and 102,000 tons of "probable ore" of the average value of 6·25 dwt. per ton.

Ipoh Tin Dredging.—This company was formed in 1913 to acquire alluvial tin properties in the State of Perak, F.M.S. The report for the year ended March 31 last shows that the dredges treated 1,351,100 cu. yd. of ground, recovering 466 tons of tin concentrates, the working profit being £21,024, as compared with £37,430 the year before, and £12,500 was distributed as dividends, equal to 15%. Additional ground near Ayer Hitam has been purchased by the company and the dredge which belonged to the Ampang (Perak) Tin Dredging company has also been purchased.

Kent (F.M.S.) Tin Dredging.—This company was formed in 1926 to work alluvial tin property in the F.M.S. The report for the year 1929 shows that 1,812,080 cu. yd. of ground was treated, yielding 573½ tons of concentrates, worth £66,663. The working profit for the year was £44,256, as compared with £26,440 during the eight months worked in 1928. The profit available after making allowances for depreciation, plant and other items, was £31,763, of which £26,250 was distributed as dividends, equal to 25%.

Aramayo de Mines en Bolivie.—This company was formed in 1916 in Switzerland to acquire tin mining properties in Bolivia. During 1929 the profit was £250,124 as compared with £192,044 in the previous year. This increase is due entirely to larger revenue from the sales of silver. During the year 4,281 tons of high-grade tin concentrates were sold at an average price of £103 as compared with 4,229½ tons averaging £115 in 1928. Low-grade tin concentrates realized £42 per ton and 314½ tons were sold. The sale of silver in the form of precipitated sulphides was 3,263,849 troy oz. at an average price of 25·8d. as against 1,683, 180 troy oz. sold in 1928 at 28·3d. per oz., and the sale of rich shipping ore was 44,988 oz. The output of cement copper during 1929 was 450 tons and 243 tons was sold at an average price of £47 11s. 8d. per ton as against 349 tons at £31 5s. 4d. in 1928. The output of bismuth in bars, residues and rich shipping ore was 125,897 and in view of high stocks held production of this metal has been suspended. Dividends paid during the year absorbed £201,600, equal to 20%.

Poderosa.—This company was formed in 1908 to acquire copper mines in the Collahuasi district, Province of Tarapaca, Chile. The report for the year 1929 shows that 14,638 tons or ore, averaging 18% copper and 5½ oz. silver per ton, was shipped to the smelters, as compared with 12,515 tons, averaging 23·5% copper and 6·47 oz. silver per ton, in 1928. The revenue from the sales of ore was £169,115, and the net profit £34,005. Dividends absorbed £22,838, equal to 10%. Lack of sufficient power has rather retarded development at the mines and steps have been taken to meet this demand.

Libiola Copper.—This company, which has worked a copper mine in northern Italy since 1867, reports a net loss of £1,738 for 1929, as compared with a profit of £69 in 1928, the sales of copper ore during the year being small. The production of copper ore during 1929 was 1,910 tons and of pyrites 11,451 tons, as compared with 2,042 tons and 11,854 tons respectively in 1928. The ore reserves at the end of the year are estimated to be 32,850 tons pyrites and 11,870 tons copper ore as compared with 37,830 tons and 11,580 tons respectively at the end of the previous year. The outlook for the new ore discovery at Castagna is reported as favourable and exploration on this occurrence is being forwarded.

Cyprus Asbestos.—This company, formed in 1921 to operate mines at Amiandos-on-Troodos, reports that during 1929 a net profit of £45,103 was made, as compared with £61,036 in 1928. During the year 2,109,620 tons of rock was mined, 407,224 tons of ore milled, and 14,110 tons of fibre produced. This compares with 16,287 tons of fibre produced during 1928. The production capacity of the property has been raised to 20,000 tons per annum, although, unless world conditions improve, output may have to be restricted during the current year.

DIVIDENDS DECLARED

Apex Mines.—6d., less tax, payable August 7.

Aramayo Mines.—5%.

Ayer Hitam Tin Dredging.—1½d., less tax, payable July 10.

Broken Hill South.—1s., less tax, payable August 15.

Burma Corporation.—6 annas, payable August 15.

Cam and Motor.—2s., less tax.

Camp Bird.—Pref. 8%, payable July 1.

Consolidated African Selection Trust.—1s. 9d., less tax, payable August 5.

Consolidated Diamond Mines of South-West Africa.—Pref. 4½d., less tax, payable August 15.

Crown Diamond.—1½d., less tax, payable August 18.

De Beers Consolidated.—Pref. 10s., less tax, payable July 31.

Electrolytic Zinc.—4%, less tax, payable Sept. 4.

Esperanza Copper and Sulphur.—7%, less tax, payable June 30.

Frontino and Bolivia.—Pref. 1s., less tax, payable July 1.

Gopeng Consolidated.—9d., less tax, payable July 7.

Hongkong Tin.—3d., less tax, payable June 30.

Ipoh Tin Dredging.—7½d., less tax, payable July 12.

Jelapang Tin Dredging.—6d., less tax, payable June 30.

Messina (Transvaal) Development.—9d., less tax, payable July 4.

New Consort Gold.—7½%, less tax.

North Broken Hill.—1s. 6d., less tax, payable June 30.

Onverwacht Platinum.—3d., less tax, payable July 31.

Otavi Mines and Railway.—3s., less tax.

Pari Tin.—1½d., less tax, payable June 26.

Rawang Concessions.—6d., less tax, payable June 30.

Rezende Mines.—2s. 6d., less tax, payable August.

Santa Gertrudis.—1s. 6d., less tax, payable July 10.

Sherwood Starr Gold.—9d., less tax, payable August.

South African Coal Estates (Witbank).—6d., less tax.

South Kalgurli Consolidated.—1s. 6d., less tax, payable August 1.

Southern Tronoh Tin Dredging.—1½d., less tax, payable July 9.

Tronoh Mines.—3d., less tax, payable June 30.

Willoughby's Consolidated.—3d., less tax, payable June 26.

NEW COMPANIES REGISTERED

Anglo American Engineering Corporation.—Registered June 21. Nominal capital: £15,000 in £1 shares (7,500 Preference and 7,500 Ordinary). Objects: To acquire property and rights of all kinds; to carry on the business of miners, smelters, engineers, colliery proprietors, etc. Office: King William-Street House, E.C. 4.

Belasica Mines. Registered June 5. Nominal Capital: £137,500, in 5s. shares. Objects: To acquire concessions and mining rights, to adopt an agreement with Dr. C. Lucie-Rocchi and Selection Trust, and to carry on the business of miners, metallurgists, etc. Directors: A. C. Beatty, J. A. Dunn, R. Micklem, D. Sokolow, and J. Whitehouse. Office: Selection Trust Buildings, Mason's-avenue, Coleman-street, E.C. 2.

Hausa (Nigeria).—Registered July 3. Capital: £15,000 in 4s. shares. Objects: To adopt an agreement with Hausa (Nigeria) (in liquidation), and to acquire any properties. Office: Broad Street House, Old Broad Street, E.C.

Kopaonik Mines. Registered June 5. Nominal Capital: £137,500 in 5s. shares. Objects: To adopt an agreement with G. N. Pasic and the Selection Trust, and to carry on the business of mine owners, etc. Directors and Office: As Belasica Mines above.

Rawang Tin Fields. Particulars filed May 23. Capital: £1,000,000 in 10s. shares. Objects: The company was incorporated in the Federated Malay States on March 19, 1929, to acquire and amalgamate Rawang Tin, Ltd., Serendah Tin, Ltd., and Serandah South Tin, Ltd., to acquire freehold and other properties, mines, etc. Office: In the State of Selangor. British office: 31 and 33 Bishopsgate, E.C. 2. Directors: F. G. Pratten, J. M. Newman, A. P. Penman, G. H. Hutton, T. A. Duffy, F. G. Pratten, Jnr., E. H. Pratten, Sir William D. Henry.

Siparia Trinidad Oilfields. Registered June 11. Nominal Capital: £500,000 in £1 shares. Objects: To adopt an agreement with the Venezuelan Consolidated Oilfields, and to carry on the business of prospectors, refiners of and dealers in petroleum and other oils and natural gas.

COMPANY MEETINGS AND REPORTS SECTION

IPOH TIN DREDGING, LTD.

Directors : R. Pawle (*Chairman*), D. T. Lewis, R. Sancroft Baker, E. T. McCarthy, L. G. Attenborough. *Secretary :* J. Barnes. *Office :* 4, London Wall Buildings, E.C. 2. *Formed* 1913. *Capital issued :* £160,000 in 16s. shares.

Business : Operates alluvial tin properties in Malaya.

The sixteenth ordinary general meeting of the shareholders of Ipoh Tin Dredging, Ltd., was held on July 7, at Winchester House, E.C., Mr. R. Pawle (Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said : The result of the past year's working has been disappointing. The production of concentrate, owing to the No. 2 dredge having struck a poor area of ground, fell off to the extent of some 70 tons, and this, together with the serious fall in the price of the metal, combined to lower our profits from £30,268 to £19,065 odd. I am afraid, therefore, that you will have to be content with a very greatly reduced dividend. You have received an interim of 7½d., and we do not feel justified in recommending a final dividend exceeding this amount, making 1s. 3d. a share for the year.

The No. 1 dredge has been shut down for the past three months. One reason for this is that there are only about two years' life in front of it in virgin ground, and this is so difficult to dig that it could barely pay expenses with tin at the price existing then and which is still lower to-day. Another reason for stopping this dredge was to enable us to comply with the restriction scheme of the Tin Producers' Association, of which we are a member, and to allow us to work the No. 2 dredge full time.

Recently a property having an area of some 400 acres has come on offer to us, which, owing to our being in a position to deal with it on a cash basis, we have been able to acquire on what we consider to be very favourable terms. At the same time, a large modern dredge, built by Messrs. William Simons and Co., Ltd., of Renfrew, came into the market, and this, too, we have acquired, together with various spares, loose plant, bungalows, buildings, etc., for a sum of £35,000, and we reckon that the cost of dismantling, alterations and additions to bring it right up to date, plus transport and re-erection, etc., will cost another £20,000. The machine, which was purchased from the Ampang Tin Dredging Company, Ltd., now in liquidation, worked for only a few months, and so may be regarded as practically new. Its capacity is not less than 150,000 cubic yards a month. We have a high grade area of about 85 acres, which we reckon will take three years to work out, and, on the basis of tin at £160 a ton, which was the price ruling when the deal was made, the net profit, after writing off the whole of the land and the dredge, should be approximately £100,000, leaving the balance of the property, some 300 odd acres of lower grade ground, averaging about ½ lb. concentrate to the cubic yard, and the dredge, free of all cost whatsoever. With no charge for depreciation or amortisation, and with a high capacity dredge, this larger lower grade area, with tin at anything like a reasonable price, should yield us a very handsome profit. All of this has been made possible by the policy which your Board has pursued of building up a substantial reserve fund, and which has allowed us to carry through this very important deal without calling upon the shareholders for an extra penny. It will take at least a year to get the Ampang dredge ready to work on the new area. By that time, it is to be hoped that the world's trade will have revived and that we shall see the price of tin a good deal above the abnormal level to which it has sunk. Should, however, the depression continue, we shall seriously consider the advisability of leaving the new property alone until such time as the price of tin justifies its working.

I would now like to make a few remarks about the Tin Producers' Association, of which this company is a member. We have faithfully complied with the Association's recommendation to curtail our output to 80% of the 1929 production, but, owing to the existing world-wide depression of trade, this degree of restriction is not sufficient to counteract the great falling-off in the consumption of the metal. More drastic measures are needed to reduce the large existing stocks of tin, and the proposal has been made for all of those companies operating in the Federated Malay States, Siam and Burma to close down altogether for a period of from two to three months. Nigerian, Bolivian and Dutch producers have, I understand, agreed to enter into a corresponding degree of curtailment of output, if we Eastern producers agree to the recommendation which has been put forward. If the majority of producers accept this recommendation, we shall not be slow to toe the line. In fact, we have made all arrangements for doing so, and have ascertained from our manager, Mr. Fulton, that the cost of a shut down will be about £500 a month. It is not a pleasant thing to contemplate, but a moderate rise in the price of tin, through this curtailment of output, will soon compensate us for the stoppage. So soon as anything definite has been decided, we will notify all shareholders either by circular or by notice in the Press.

With a reversion to normal times, which I hope will not long be delayed, this company, for the reasons which I have explained, should enjoy a prosperous career for a good many years to come. Our success in the past must be our hope for the future, and that our success has been great will be more readily understood when I tell you that up to date, and including the dividend now due, this company has paid out to the shareholders no less a sum than £306,693, subject, of course, to tax, while our capital from the point of view of the market is still intact.

Mr. E. T. McCarthy seconded the resolution, and it was carried unanimously.

INDIAN COPPER CORPORATION, LTD.

Directors : Sir G. B. H. Fell (*Chairman*), Sir W. D. Henry, Hon. Lionel Holland, E. T. McCarthy, H. C. Taylor, Lt.-Col. J. H. M. Greenly. *Technical Managers :* Anglo-Oriental Mining Corporation, Ltd. *Secretaries :* Anglo-Oriental and General Investment Trust, Ltd. *Office :* 31 and 33, Bishopsgate, London, E.C. 2. *Formed* 1924. *Capital issued :* £301,032 18s. in 2s. shares.

Business : Operates copper and other properties in Chota Nagpur, India.

The sixth ordinary general meeting of the shareholders of Indian Copper Corporation, Ltd., was held on June 16 at Winchester House, Old Broad Street, E.C., Sir Godfrey B. H. Fell (Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, said : Net proceeds of copper, with stocks in hand, amounted to £143,134 10s. 6d., to which must be added sundry receipts, £4,315 15s. 10d., and transfer fees, £511 2s. 6d., making a total of £147,961 8s. 10d. After defraying operating costs, £74,425 14s. 5d., mine administration and general expenses, £15,969 9s. 9d., London office administration and general expenses, £5,380 0s. 11d., directors' fees, £2,216 13s. 4d., and interest, £4,554 6s., there is a gross profit of £45,415 4s. 5d., which is taken to the balance-sheet. Out of this falls to be met debenture interest for nine months from April 1 to December 31, amounting to £16,779 10s. 7d. From April 1, debenture interest has been met from revenue, and, after deducting this amount, £16,779 10s. 7d., there remains a sum of £28,635 13s. 10d. to be disposed of.

We propose to deal with this sum as follows. Firstly by transferring to development redemption reserve the sum of £10,798 13s. 6d. Secondly, by writing off from mining development and general expenditure a sum of £8,077 6s. 9d. These two amounts total £18,876 0s. 3d., and the balance of £9,759 13s. 7d. it is proposed to carry forward.

The programme we set before us was the treatment of 100,000 short tons of ore in a full year. Actually, the mine despatched to the mill 82,912 short dry tons of ore, of which 52,089 tons were despatched in the second six months of the year. For the first quarter of the current year the output was 31,783 short tons. The average grade of underground ore reserves has been re-estimated by your general manager at 3·38%. This is lower by ·49% than his previous estimate, but stoping has revealed much greater widths of payable ore than was at first thought to be the case. The underground ore reserves at the close of the year showed an increase of 64,577 short tons, while 81,740 short tons were also broken in stopes during the year for transmission to the mill.

The primary crushing plant functioned smoothly throughout the year, except for an accident to the main shaft, which was replaced by a shaft made in your own workshops ; but the character of the ore rendered it desirable to instal a Symons' cone crusher in lieu of the existing rolls. This new plant is now erected and in operation, with the addition of a belt to facilitate hand-picking. It is anticipated that the grade of ore will be improved and the size of ore transmitted to the Hardinge mills will be materially reduced, thus enabling the latter to treat a larger tonnage and reducing the wear on those mills. The first reports on the operation of this unit are most satisfactory.

The operation of the mill was extremely satisfactory throughout the year. The percentage of extraction for the year was 95·73% on mine ore, and 94·8% over-all recovery of mine and dump ore.

From the smelter 1,635 long tons of refined copper were produced. Over-all extraction from ore to refined copper was, on mine ore, over 90% and on mixed mine and surface dump ore 89·2%.

The power house, boiler house, pulverized coal plant and water supply have functioned smoothly throughout the year and have more than fulfilled the expectations of those who were responsible for their design.

Sales of kyanite have largely increased during the year, and we are looking forward hopefully to a still further development of this subsidiary activity of the corporation.

The health of both camps has been satisfactory, and the relations between the management and the Indian labour have continued to be excellent.

Before I conclude my remarks, I should like to give a very brief resumé of the progress achieved since the end of the year under review. At the mine vigorous efforts have been made to increase the output of ore, which attained its highest monthly output to date in April. The grade is also improving. Good progress has been made with the driving of No. 3 intermediate level. The handling of the ore from the stopes will, it is anticipated, be greatly facilitated and cheapened by the installation of a La Mancha trammer, which was put into commission a few weeks ago. At Moubhandar, the Hardinge mills should, as I have already mentioned, benefit by the finer crushing of the ore in the new Symons cone crusher installed at the mine. Larger converters are being installed and should shortly be in use, with a resultant increase in the output of blister copper. The output of the refinery has amounted to 1,095 long tons in the first five months of the year, an average of 219 tons a month.

Excellent progress has been made with the rolling mill. It is practically complete in every respect, and trial runs should be made in the course of this month.

The recent heavy fall in the world price of copper is a matter which unfortunately cannot be ignored. We are hopeful of disposing of the whole of our increased output, either in the form of copper ingot or of sheet, at prices which are still remunerative and which we may see improve before long. It only remains for me, before I sit down, to pay a tribute to the admirable work performed by your general manager and his staff in India throughout the year.

The Hon. Lionel Holland seconded the motion, which was carried unanimously.

BRITISH-BORNEO PETROLEUM SYNDICATE, LTD.

Directors : Walter Maclachlan (*Chairman and Managing Director*), H. Lloyd Chittenden, F. H. Hamilton, William Cullen, Hugh Limebeer. *Secretary :* H. A. Searle. *Office :* 2, Broad Street Place, London, E.C. 2. *Formed* 1912. *Capital :* £250,000 in 10s. shares.

Business : Finance of and investment in oil ventures in various parts of the world.

The sixteenth ordinary general meeting of members of the British-Borneo Petroleum Syndicate, Ltd., was held on June 25 at Winchester House, Old Broad Street, E.C., Mr. Walter Maclachlan (Chairman and Managing Director of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said : The balance-sheet shows that the share capital remains at £250,000, consisting of 500,000 shares of 10s. each which are fully paid. Turning now to the profit and loss account, a gross income is shown for the year of £31,389 and a net profit of £28,316. The undistributed profits brought forward from the previous year amounted to £38,315, making a total disposable profit of £66,632 at the credit of the profit and loss account. Of this, £12,500 has been distributed in respect of interim dividend No. 14, of 5%, less tax, and it is now proposed to pay a final dividend, No. 15, of 7½%, less tax, making a total dividend return of 12½% for the year ended March 31 last. This will leave £35,382 of undistributed profit to be brought into the accounts for the current year.

I shall now review the principal interests of the syndicate which are represented in our balance-sheet by the £247,161 of capital expenditure. The most important of these continues to be our holding in the Apex (Trinidad) Oilfields, Ltd. During the financial year of that company, which ended on September 30, 1929, its production of oil amounted to 414,328 tons, which constituted a further record year's output from the Apex Oilfields. The net profit for the year amounted to £313,208, after making ample provision for depreciation and amortisation of the wells, and the dividends paid in respect of last year amounted to 52½%. The production for the first eight months of the current year to May 31, has amounted to 268,000 tons, which is practically the same as that for the corresponding period of 1928–29, and we anticipate that the output for this year will be not less than for the preceding year. The development of the property continues to be attended with most satisfactory results.

As you are aware, we hold, in conjunction with other important groups, a substantial interest in the Oilwells Selection Corporation, which owns substantially the entire share capital of a Rumanian company called the Apex Roumanian Drilling and Oil Industry Supply Company, carrying on business of the nature denoted by its title. As has previously been reported to you, that company has practically from the start of its career suffered from the unsatisfactory conditions of the oil industry of Rumania. On the occasion of our meeting last year, however, we were able to report an improvement in these conditions from which the Apex Roumanian Company was deriving material benefit, particularly as regards its trading department.

Owing, however, to the large overproduction which is now taking place in Rumania, the oil industry there is again faced with a heavy fall in the price of crude oil, which it is now only possible to sell with great difficulty and at extremely low prices. As a result of this, there has been practically a stoppage of the work of the contract drilling department, which it has therefore been decided to close down for the present. With regard to the two oilwells which had been drilled on participation or partnership terms, the Roumanian Company decided to enter into no further business of this nature. The trading department, however, has continued to make satisfactory progress, and the turnover during 1929 shows a great increase over that for the previous year, and resulted in a substantial profit.

It is necessary to provide for writing down substantially the value of the contract drilling and other plant, together with the balance of the cost of the two participation wells. It is proposed to reduce the issued capital of the corporation from shares of £1 each to shares of 10s. each.

We are also interested in a Rumanian oil company whose capital is owned by the London and Midland Oil Company, in which we are interested jointly with another London group. This Rumanian company is operating on the Bordeni Oilfield, but under the unsatisfactory conditions caused by the heavy fall in the price of oil in Rumania, it is impossible for crude oil producers not owning refineries to carry on remunerative business. Operations on the Bordeni Oilfield, therefore, meantime have been suspended, with the exception of the production of the moderate output of oil which is yielded by the existing wells, the proceeds of which are applied towards the maintenance of the property.

I have to report that the Singapore Oil Syndicate are continuing their drilling operations at the Klias Peninsula, but so far they have not been successful in obtaining production in commercial quantity.

We are also interested in oil operations which are being carried on in Brunei by the British Malayan Petroleum Company, a subsidiary of the Royal Dutch-Shell group. The British Malayan Company is actively engaged in geological investigation and drilling operations in that territory which are being attended with encouraging results, and the great success of the Royal Dutch-Shell group in immediately adjoining oil-bearing territory in Sarawak gives us the hope that successful results may be obtained in Brunei. The exceptionally adverse conditions which have prevailed during the greater part of the past year have been most unfavourable for profitable business, and we consider ourselves fortunate in having avoided the heavy losses and depreciation in securities which have been experienced by so many similar undertakings.

During the year under review there has been little scope for undertaking any new business, either in association with the oil industry or otherwise.

Mr. Frederick H. Hamilton seconded the resolution, and, after the Chairman had replied to a few questions, it was carried unanimously.

SONS OF GWALIA, LTD.

Directors : C. Algernon Moreing (*Chairman*), N. W. Diggle, E. A. Loring, J. C. Gardner, W. A. Macleod (*Managing Director*). *General Managers :* Bewick, Moreing and Co. *Secretary :* E. Pears. *Office :* 20, Copthall Avenue, London, E.C. 2. *Formed* 1898. *Capital issued :* £325,000 in £1 shares.

Business : Operates gold properties in the Coolgardie district of Western Australia.

The thirty-third ordinary general meeting of the members of the Sons of Gwalia, Ltd., was held at the registered office, No. 20, Copthall Avenue, London Wall, London, E.C., on Wednesday, June 18, 1930, Mr. C. Algernon Moreing (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, said : The balance sheet and the profit and loss account show that the position has somewhat improved as compared with that of the preceding year, the respective deficits on the profit and loss account being for the year 1928 £4,341 6s. 2d. and for 1929 £2,678 7s. 3d. This improvement, however, is small and by no means comparable to that which should have been made but for the irreconcilable attitude of the labour unions with regard to underground working conditions. In 1929 we mined 118,328 tons of ore for an expenditure of £80,434 12s. 11d. as compared with 121,058 tons for an expenditure of £80,269 19s. in 1928, and for the same two years the expenditure on ore treatment stands at £32,363 12s. 5d. and £33,329 0s. 1d., and on the re-treatment of sands and slimes at £7,744 2s. 7d. and £7,578 7s. 4d.

The development of the mine has been a matter of great urgency, more particularly in the deeper ground where the better values occur. In 1928 the developments totalled 4,841 ft., and in the year under review 5,210 ft. One of the most important items demanding attention has been the sinking of the main shaft. Prior to resumption of sinking this shaft below No. 25 level a large amount of winzing was carried to depths of over 150 ft. below that level, which work indicated that the ore bodies lived strongly and maintained their values well at that depth.

We may view with satisfaction the general results of the developments of the past year and the preceding one in that the work in the bottom levels gives every indication of persistence in depth of good values and that this work is well supported by that on the line of continuation of the South Gwalia shoot. Further, the work of the current year has so far disclosed nothing to cause us to modify these opinions.

During the year the average grade of the ore treated was 22·72s. and the average value of the residue was 2·35s. and the average extraction was 89·7% as compared with 89·3% for the preceding year.

The expenditure for the year on equipment and machinery was relatively small and was confined mainly to the completion of the installation for the recuperation of the waste heat from the exhaust of the gas engines.

Mr. E. A. Loring seconded the motion, which was carried unanimously.

TAQUAH AND ABOSSO MINES, LTD.

Directors : T. F. Dalglish (*Chairman*), G. W. Campion, R. F. Rugg, G. W. Staples. *Secretary :* T. J. Foster. *Office :* 264–273, Salisbury House, London Wall, E.C. 2. *Formed* 1927. *Capital issued :* £233,307 10s. in 5s. shares.

Business : Operates gold mines in the Gold Coast, West Africa.

The ordinary general meeting of the members of Taquah and Abosso Mines, Ltd., was held on June 26 at River Plate House, Finsbury Circus, E.C., Mr. T. F. Dalglish (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said : The resolutions passed at the extraordinary general meeting of the shareholders on March 24 last for the reduction of the capital of the company were duly submitted to the Court, but it was not until April 14 we received confirmation. Consequently we were unable to give effect to these in the accounts now submitted to you, which are dated March 31. You have only to deduct the amount of the suspense account from the amount of capital issued, which gives the reduced figure of £186,646.

Turning now to the profit and loss account, the tonnage of ore treated was, for the reason stated in the report, 14,797 less than in the previous year, and the amount of gold recovery was £168,558, a reduction of £5,825. In the year 1928–29 the recovery was 30s. 2d. per ton, as compared with 33s. 5·3d. during the year now under review, which thus shows an increase of 3s. 3·3d. per ton. On the other hand, the mine working costs, including development redemption, show a reduction.

Sinking of the internal shaft is proceeding to connect with No. 18 level, now being opened from the bottom of the winze from No. 17 level. This connexion will add materially to our reserves. Of equal importance, levels Nos. 16, 17 and 18 north are being pushed on in reef of good values. When the borehole on No. 13 level north locates the reef a large lateral development can be undertaken. The benefit during the year of the introduction of jackhammers in large numbers into the mine and the conversion of our compressors to electric drive is reflected in the reduction of our costs.

We have taken up an additional area north of the Cinnamon Bippo concession which we hold. As it would appear to us that a new era of possibilities has been opened on the Taquah banket reef by the use of jackhammers, we considered it advisable to secure a lease of this adjoining property, which would secure to us the ground opened up by the old Cinnamon Bippo Company and beyond. At the suggestion of Mr. Campion the records of that company have been submitted to a well-known engineer. He has examined these carefully and considers the proposition well worth serious consideration.

Mr. R. F. Rugg seconded the resolution, which was carried unanimously.

PODEROSA MINING CO., LTD.

Directors : Lionel W. Harris (*Chairman*), W. J. Barnett, V. Echeverria, A. Fergusson. *General Manager :* R. O. Packard. *Secretaries :* James Rennie and Co. *Office :* 145, Dashwood House, Old Broad Street, London, E.C. 2. *Formed* 1908. *Capital issued :* £290,000.

Business : Operates copper properties in Chile.

The twenty-first annual general meeting of the shareholders of the Poderosa Mining Company, Ltd., was held on June 25 at the offices of the company, Dashwood House, Old Broad Street, E.C., Mr. Lionel W. Harris (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, said: Turning to the revenue account, the proceeds of sales of ore are practically the same as last year. The result, after providing £8,361 for British income-tax and £1,596 adjustment of valuation of investments, is a net profit of £34,004 11s. 4d., to which falls to be added £8,048 8s. 7d. brought forward from the previous year, leaving £42,052 19s. 11d. to be dealt with. We propose that the balance be applied in payment of a final dividend of 5% and that the balance of £19,215 9s. 11d. should be carried forward.

Although development work at the mines was on a larger scale than in any year since 1924, it did not attain the progress anticipated, owing to shortage of power. The question of power at the Poderosa mine has therefore received very careful consideration, and an order has been placed for a 300 h.p. Diesel engine electric generating set.

The production for the year was obtained partly from the San Carlos lode on level No. 10 north and south and partly from the main Caunter lode on the same level.

The price of copper was favourable to us during the year, but at the present price of 12 c. there is no profit. Although the prospects for the remainder of the current year do not appear to be very bright, your company is now in such a financial position as to be able to carry on until times improve.

Mr. William J. Barnett seconded the resolution and said: The manager's report, I think you will agree, explains very clearly the development of the mines and also states the various points from which this will be continued in order to open up further ore. He mentions the occurrence in the mine of a "gossan zone." This means that the various metalliferous minerals in the lodes have been ozidized and dissolved out in that zone. These minerals have been redeposited at a lower horizon and constitute the enriched sulphides of copper which account for the high-grade shipping ore we are now producing.

The cable we have just received from our general manager states that on No. 11 level, which is at a depth of over 800 ft. from the surface, we have a lode containing for over 4 ft. in width an average of 33% copper. This value at so great a depth is most encouraging.

The resolution was carried unanimously.

ARAMAYO MINES IN BOLIVIA CO.

Directors : C. V. Aramayo (*Chairman*), A. Charpentier, L. Martin, G. Ferrière, L. Patry. *Secretary :* L. Patry. *Office :* 16, Quai de la Poste, Geneva. *Formed* 1916. *Capital :* Fr. 25,200,000 in Fr. 25 shares.

Business : Operates tin, silver, copper and bismuth properties in Bolivia.

The tenth ordinary general meeting of Aramayo Mines in Bolivia Company was held on June 30 at the company's offices, Geneva, Dr. Albert Charpentier presiding, in the absence of the Chairman, Mr. Carlos V. Aramayo.

Dr. Charpentier, in moving the adoption of the report and accounts for the year 1929, said: The balance of profit and loss account at December 31, 1929, as remitted by the Bolivian office, shows a profit of Swiss francs 6,802,988·35 (£272,119) as the result of the year's work. With the adjustment of various items, the final figure of profit in 1929 is Swiss francs 6,253,089·65 (£250,124). The corresponding figure in the previous year was Swiss francs 4,801,094·99 (£192,044). The increase is due entirely to the larger revenue from sales of silver, the output of which reached a higher figure in 1929 than in 1928.

The sale of high-grade tin concentrates during the year 1929 was 4,281 tons, at an average price of £103 5s. 11¾d., as against 4,229·5 tons sold in 1928, at an average price of £114 14s. 8½d. The sale of low-grade tin concentrates, the production of which has now become a more important feature, was 314·5 tons, at an average price of £42 6s. 1½d. per ton. The sale of silver in the form of precipitated sulphide was 3,263,849·64 troy ounces, at an average price of 25·8d., as against 1,683,180·46 troy ounces sold in 1928, at the average price of 28·3d., and that of rich shipping ore was 44,988·07 troy ounces at 22·13d., as against 21,911·62 troy ounces at 24·6d. The sale of copper cement was 243·3 tons at an average price of £47 11s. 8d. per ton, as against 348·9 tons at an average price of £31 5s. 4d. per ton.

The total number of metres driven in development work during the year was 2,164·45, of which 516·50 metres were vertical drives for providing ore blocks for economical stoping. In the previous year 1,625·25 metres were driven in development work. Of the horizontal driving carried out during the year, 847 metres (or more than half the total) were accounted for by the advance of the new drainage tunnel of Chorolque. For this reason the programme of more intensive development at Chocaya which had been decided upon was considerably delayed, and it was not until the present year that the central shaft at Animas reached the 302 level.

Chocaya ore reserves were estimated on January 1, 1930, to be 131,468 tons silver-tin ore containing 53·17 oz. silver to the ton and 3·84% tin, and 72,131 tons tin-silver ore containing 6·0% tin and 8·36 oz. silver per ton.

In spite of constantly falling prices, mining operations on the company's properties for the first quarter of the current year have shown a profit. I am happy to state that the management of the company's properties by the managing firm is giving entire satisfaction.

The resolutions were carried unanimously.

ESPERANZA COPPER AND SULPHUR CO., LTD.

Directors : T. D. Lawther (*Chairman and Managing Director*), Arthur Henderson, David Maxwell, C. H. Graham, J. E. W. Lomas, Lauchlan Rose. *Secretary :* F. A. Cassini. *Office :* 310, Caxton House, London, S.W. 1. *Formed* 1906. *Capital issued :* £300,000 in £1 shares.

Business : Holds interests in copper and sulphur properties in Spain and Cyprus.

The annual general meeting of the Esperanza Copper and Sulphur Company, Ltd., was held on June 12 at Caxton House, S.W., Mr. T. D. Lawther (Chairman and Managing Director of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1929, referred first to the various items. He proceeded to say that the company was mainly interested in its two subsidiaries, the Seville Sulphur and Copper Company, Ltd., operating in Spain, and the Cyprus Sulphur and Copper Company, Ltd., operating in the Crown Colony of Cyprus.

After referring to some of the difficulties experienced during the war, the Chairman continued :—The shipping of Seville ore is the only remaining difficulty, which the ropeway scheme is specially designed to solve. Very extensive alterations to the port of Seville have been undertaken by the Spanish Government in recent years, but unfortunately, our pier is left high and dry as the result of these alterations, and in consequence a new pier has been designed and is expected to be ready shortly. The improvement in shipping conditions accruing from the ropeway will altogether revolutionise the future of Aznalcollar.

Of the Cyprus property, in which they held over three-fourths of the shares, the Chairman said this company owns a mining concession 30 square miles in area, situated near the town of Polis, in the western end of the island. It also owns freehold surface property around Lymni mine extending to some 200 acres. Last year it was decided to attack the low-grade mineral by the opencast method, and the work of overburden removal has since been in progress. By the end of this year it is expected that the overburden will be sufficiently advanced to allow of mineral extraction and the laying down of mineral heaps for lixiviation, and then the production of copper precipitate will commence. One of the overburden adits has passed through some clean pyrites of good quality, similar to the pyrites discovered, also accidentally, in 1914 at Skouriotissa.

In our 30 square miles concession area there are other points awaiting development besides that at Lymni to which I have just been referring, but the work here involves drilling and is in the nature of mining adventure ; the money spent must be risked, and so far our subsidiary has had little money available. It will, however, be the subject of future proposals to you—one thing at a time is good practice in mining.

I hope the foregoing is sufficient to indicate to you that our capital is well invested in substantial mining properties, each valued on a very low basis and each with considerable prospects for the future in the profitable exploitation of known mineral ore reserves as well as in opening up new reserves.

The report was unanimously adopted.

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