The Mining Magazine

Managing Director: W. F. White.
Assistant: St. J. R. C. Shepherd, A.R.S.M., D.I.C., F.G.S.

Editor: Edward Walker, M.Sc., F.G.S.
Assistant: F. Higham, A.R.S.M., M.Sc., F.G.S.

Published on the 15th of each month by Mining Publications, Limited, at Salisbury House, London, E.C. 2.

Telephone: *London Wall* 8938. Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions, *& Bentley.*

Branch Offices { New York: Amer. Inst. M. & M.E. / Chicago: 360, N. Michigan Blvd

Subscription { 12s. per annum, including postage. / U.S.A., \$3 per annum, including postage.

Vol. XLI. No. 4. LONDON, OCTOBER, 1929. PRICE ONE SHILLING

CONTENTS

EDITORIAL

THE Institution of Mining and Metallurgy is paying an official visit to South Wales on October 22 and 23, when tours will be made of the works of the Mond Nickel Co., Ltd., at Clydach, and of the National Smelting Co., Ltd., at Swansea Vale, by invitation of the directors of those companies.

IN this issue an article by Mr. W. L. H. Morrison is published on the estimation of the contents of tin alluvials in which he argues that some methods now in vogue are not sufficiently accurate when low-grade deposits are being tested. The article is a contentious one and some readers may differ from the author. Such readers are free to express their own views and experience.

ANY new venture relating to the use of tin is of interest nowadays. It is announced that a steamer, the Ganges, of 10,000 tons capacity, is being converted at Hull into a floating cannery. The vessel will be followed by a fleet of small boats to be used for catching lobsters, crabs, and crayfish, which will without delay be transferred to the steamer, to be cooked and canned.

ONE of the drawbacks to life in the Northern Rhodesia copper fields is the prevalence of malaria. It is welcome news therefore that at the suggestion of the Ross Institute Industrial Anti-Malarial Advisory Committee an expedition of malaria experts has been organized with the object of undertaking preventive work. The party, which left London on September 27, consists of Sir William Simpson, Director of Tropical Hygiene at the Ross Institute, Mr. C. R. Harrison, who has had much experience in Malaya, and Dr. A. Dalzell.

READERS are aware that we record the doings of diviners, holding that in these days of scientific wonders it is idle to scoff at their efforts. The latest public experiments were made on August 21 in the grounds of the Plymouth Museum and Art Gallery by Mr. Frederick Stone, of North Devon, under the supervision of Mr. A. J. Caddie, the Curator. Mr. Stone used a steel spring instead of the usual hazel twig and it is reported that he was successful in detecting the presence of hidden gold objects. Though we have some respect for those who believe in the divining rod, we do not see our way to go into details, and merely put the foregoing on record so that those who are interested in the subject may communicate with the Curator and obtain the facts for themselves.

SIR DOUGLAS MAWSON and his party of explorers left Adelaide on September 18 for Cape Town, where they will join the *Discovery* and proceed to the Antarctic continent. This ship is fitted with equipment of which Captain Scott never dreamt when he undertook the South Pole journey in 1901. Sir Douglas has taken part in two previous expeditions to these regions, one with Shackleton in 1907–9 and one under his own leadership in 1911–14. He will be the geologist of the present party and no doubt mineral deposits will receive due attention. So far there is little record of commercial occurrences of ore in that part of the world, but coal has been found. This latter formed the subject of an article in the MAGAZINE for December, 1917, by Dr. Griffith Taylor, who was senior geologist in Captain Scott's expedition of 1910.

THE mica deposits of Bihar and Orissa are probably the largest in the world and their output is of considerable importance in the electrical industry. The operating companies are, however, seriously handicapped by the illicit disposal of the product and the official reports of exports from the district are quite double the figures of production reported by them. Mica mining is an industry that cannot usually be conducted on a modern systematic scale, and a large proportion of the output is necessarily produced by small workers. These conditions are favourable to the surreptitious extraction of the mineral in out-of-the-way places in the jungle. The position is similar to that which used to prevail in South Africa in connection with diamonds and the Bihar Legislative Council is having to take steps to check the practice. The Bill now introduced provides that all dealers shall identify the source of their purchases. There seems to be some opposition to the proposals on the part of the dealers and also from the local populace, which resents the present principles of mineral possession, but the final decision of the Legislature can hardly be on the side of the illicit mica buyer.

The Indian Geological Survey

Those who closely follow the politics of the East are aware of the modern tendency to place the government of India more and more in the hands of the native population of the country. Consideration of this policy does not come within the scope of a technical publication such as the MAGAZINE except in so far as it concerns the control of the mineral industry. We may say at once that the indianization of the Geological Survey of India is not welcomed by English-speaking scientific and business men. For some time this change has been gradually progressing until now the staff of the Survey consists of 20 British and 17 Indians. A few months since two vacancies occurred and it was announced that candidates must be statutory natives of India, Europeans being ineligible. This incident indicates the attitude of the authorities at the present time, but before coming to the conclusion that the Survey is to be entirely indianized as vacancies occur it is advisable to wait for the report of the Commission of which Sir John Simon is chairman.

Two questions arise when discussing this change. In the first place, an outlet for the activities of young British geologists will be closed. Secondly, it is open to doubt whether the substituted Indians will have the personality of the British, and in this connection it must be remembered the duties involved are not confined to the application of scientific knowledge, but include administration. It is doubtful whether the native of India has the same ability for absorbing the higher learning as a European, and we think it will be admitted that the holders of Indian university degrees are not, speaking generally, of as high a grade as the graduates of British universities. As for the capacity of the Indian geologist to carry out administrative duties, there is some doubt whether he can attain the same standard as the European when dealing with the directors of British mining and oil companies. For these reasons it is to be hoped that the Indian ambitions to capture the Survey will be abandoned and a policy of appointing the best men from the two countries maintained.

Estimating Ore Reserves by Bore-Hole

Judging by inquiry and comment received by the MAGAZINE it would appear that the old discussion as to the meaning of the term "ore reserves" has arisen again in several quarters. Most of these inquiries are based on the method of estimating reserves at the copper mines now being developed in Northern Rhodesia and the comment is that the figures are calculated from the results of bore-holes and not from the assay-values of ore blocked out on three sides as recommended by the rules of the Institution of Mining and Metallurgy. It is argued that according to the Institution's definition the term is not applicable to bore-hole estimates and it is suggested that in speaking of these estimates some other term should be adopted.

Our reply is that the deposits in Northern Rhodesia are not quite the same as those which the Institution had in view when the established definition was suggested. The deposits covered by the definition were essentially veins, whereas those in Rhodesia are bedded deposits in which the copper mineral is finely disseminated in a more or less regular manner through sedimentary rocks consisting of shale or sandstone. The structure of the deposits is such that within certain limits their extent and content can be estimated from bore-hole, as is the practice with coal seams and alluvial gold, platinum, and tin deposits. The certainty of the results is not so great as with coal, for in the latter case only the extent and thickness have to be estimated and the question of assay-value does not arise. With alluvial deposits the problems of estimation are almost identical in theory, but with bedded deposits in Rhodesia the conditions are far simpler. The Institution is at present engaged in endeavouring to lay down rules for estimating the contents of alluvial deposits. While it is universally admitted that there is no alternative to the bore-hole, it is felt that there can be no fixed rule as to the number of drills per acre, the number decided on in each case depending on the variableness of the results obtained. It might be suggested that the case of bedded deposits should be added to the dissertations on alluvial deposits. The Institution has also discussed the reliability of drill holes in alluvials. In the case of bedded deposits the diamond or churn drill may be accepted as giving more accurate samples of the deposits than in the case of drills used in alluvials. At the time, however, that the definition of ore reserves was issued bore-holes in rock were not recommended as entirely reliable guides, but nowadays, with direction finders and other improvements in technique, a different view might be taken by the authorities as to their reliability in estimating reserves. An examination of the reports published by the Rhodesian companies of the results of bore-hole investigation shows that the existence of the beds and their average thickness can be readily determined. The copper content is not invariable, but in the majority of cases it is sufficient to make satisfactory ore. A general survey of the results indicates that the whole of the bedded deposits would not pay to mine and that the valuable ore occurs in wide and strong shoots. By suitable arrangement of the holes the engineers are able to form an estimate of the commercial ore. In replying to the question whether the estimation of reserves by bore-hole in this case is sound policy, it is safe to say that it is, provided the practitioner is skilled in the art and faithful to his profession.

For the benefit of those unacquainted with the functions of the drill it may be said that there are different degrees of applicability of the bore-hole to the estimation of the contents of mineral deposits. For instance, it is of little or no value in ascertaining the content of diamond gravels, as it is a matter of pure luck whether a stone is ever struck at all. Similarly in the case of hematite replacements in limestone it is a question of hit or miss. In the case of lodes and veins the drill is extensively employed for discovering ore or determining its continuance, exceptionally as a means of estimating the extent or content of the ore disclosed, but usually only as an indication to aid in ordinary exploration and development, as in driving ahead of a cross-cut. On the Rand the drill has been used in testing the continuance of a reef in depth and laterally and the sinking of shafts has been warranted from the information so obtained by comparatively few holes, but reliance was never placed on the assay-value of the bores in estimating the total gold content between bores.

We have said that exceptionally the drill may be used in estimating ore reserves in lode formations. This is the case when the ore-body is massive and the values fairly evenly distributed. The same holds good with massive magmatic segregations. In these cases the estimates are not usually of as dependable a nature as those obtained with bedded deposits and the placing of the holes and the interpretation of the results require greater skill. Many of the best mining engineers and geologists have employed the method for this purpose successfully and for this reason they may be classed with the bedded deposits when discussing the reliability of the bore-hole as a guide to ore reserves.

The Uganda Waterways

Though Uganda has been British territory for nearly 40 years its development has necessarily been slow owing to its position and the nature of the country. It is only recently that through communication from the east coast of Africa to the Nile was effected by the extension of the Kenya railway to Namasagali. At the time of the opening of this extension much was said of its constituting an epoch-making event, but at the present time the event is of greater sentimental than practical importance, for there are many obstacles to travel between Namasagali and the Nile. Some of these difficulties were vividly presented by Mr. E. B. Worthington in a paper recently read before the Royal Geographical Society and reported in the *Geographical Journal* for August, and the proceedings at the lecture were made additionally interesting by contributions to the discussion by Mr. E. J. Wayland, Government Geologist of Uganda, Mr. C. W. Hobley, and others.

The Kenya railway has its terminus on Lake Victoria at Kisumu, but communication northwards from the lake to the Nile is barred by Ripon Falls at the point where the river leaves the lake, by a series of rapids, and by Owen Falls. It was primarily for the purpose of connecting with the Nile that the spur of the railway to Namasagali was built. From this terminus it is possible to go by river to Masindi Port, but the route is a difficult one as it passes through Lake Kioga, which is a swamp rather than a lake, overgrown with papyrus and water lily and inhabited by crocodiles and hippopotamuses. It is impossible to negotiate the remainder of the river to Lake Albert, for, in particular, the Murchison Falls cause an effective stoppage of traffic. Thus it is necessary to take the road to Butiaba on Lake Albert and get once more into navigable waters. The geography of this region has been confusing to travellers, owing partly to seasonal variations and also to variations of longer duration. Moreover some of the rivers have been mapped as flowing in opposite directions, the case of the Nkussi-Kafu being characteristic. Here the two parts of the river rise in a swamp, the western effluent flowing to Lake Albert and the eastern to the Nile. Lake Kioga is gradually losing its water, to some extent owing to silting, but also perhaps to tectonic movements. Probably when the erosion at Murchison Falls becomes more severe much of the lake will be left dry. Mr. Hobley, in his remarks at the meeting, urged that this drainage of Kioga should be assisted, for the reclaimed land could be employed more efficiently for the growth of cotton. Lake Albert is another body of water which is much shallower than might be expected, for in spite of the fact that it is one of the lakes of the Great Rift Valley which are usually deep it has been largely filled by the material brought down by the big rivers such as the Nile, the Semliki, and Muzizi.

Mr. Worthington studied these lakes and rivers for the Uganda Fisheries Survey. Fishing is an important industry among the natives of this region, among whom the fish and the water lily roots form important articles of food. The distribution of various species and genera of fish form puzzling problems to the zoologist and incidentally provide useful evidence for the geologist who is seeking to explain the history of these parts of Africa. Mr. Wayland contributed to this phase of the discussion on Mr. Worthington's paper and outlined the theories which have on previous occasions been quoted in the MAGAZINE. These regions, as well as those farther north and south, were in past ages a vast peneplain which was subsequently, in late Oligocene times, subjected to disturbing conditions and became warped. In the downwarps water accumulated, forming great basin lakes, the majority of which have since lost their water, though a few, notably Lake Victoria, still remain. No doubt some of these basin lakes communicated with the ocean and thus obtained their fauna. Another result of the warping was the appearance of rift valleys, which are fracture valleys running along the crests of linear upwarps, and subsequent movements put some of these valleys into connection with the basins, filling them with water and introducing fauna from the basins. Subsequent alterations in the distribution of water followed alternating periods of rainy and dry conditions, with accompanying earth movements which Mr. Wayland describes in some detail. The facts relating to the river and lake fishes confirm Mr. Wayland in his explanations, and Mr. Worthington's evidence thus adds a considerable amount of information of value to the geologist.

THE HEADWATERS OF THE NILE.

REVIEW OF MINING

Introduction.—The continued outflow of gold from this country to the Continent has at last resulted in the raising of the bank rate to $6\frac{1}{2}$%, which is likely to have an unfortunate effect in hampering trade at a time when the usual autumn revival is expected. The collapse of the Hatry group of companies has also had a depressing effect in the City. The prices of metals, especially tin, have suffered and quotations on the Stock Exchange have been somewhat limp in many sections.

Transvaal.—The output of gold on the Rand during September was 814,707 oz. and in outside districts 34,846 oz., making a total of 849,553 oz., as compared with 891,863 oz. during August. The natives employed at the gold mines at the end of September were 190,567, as compared with 190,062 at the end of August.

During the year ended June 30 last the New Modderfontein milled a record amount of ore at 1,713,000 tons and made a record profit of £2,252,433. The yield per ton was 44s. 1d., as compared with 47s. the year before, but, on the other hand, the working cost per ton was only 17s. 9d., as compared with 19s. 5d. The rich Main Reef Leader is now fully developed and the upper leaders and South Reef at present being developed are of lower grade, so that the fall in the yield per ton may be continued. By means of the extended use of mechanical appliances underground the cost per ton may be still further reduced.

For the year to June 30 last the Sub Nigel made a working profit of £454,000, as compared with £525,000 the year before, the revenue per ton being 77s. 6d. as compared with 85s., the costs per ton 44s. 9d. as compared with 41s. 7d., and the profit 31s. 2d. as compared with 41s. 9d. The average reef width was 11·1 in. and the average reef value of payable footage 38·6 dwt. The development footage on the reef was 39,179, on which the payable ore was 36·7% as compared with 42·9% the year before. The value of the payable development was lower owing to much of the work being done outside known shoots.

The New Kleinfontein has never been one of the rich properties of the Far East Rand and its most prosperous times were in the years 1906 to 1912, when dividends ranging from $12\frac{1}{2}$% to 25% were paid. Since 1921 only $2\frac{1}{2}$% was paid in 1923 and 1924 and since then nothing. In the yearly report for 1928 shareholders were warned of the doubtful future of the mine owing to the difficulty of maintaining a supply of ore of high enough grade to pay expenses. It is not surprising, therefore, to hear that the directors have decided to cease development and to extract such ore as it may be profitable to treat. The closing of this mine, thus foreshadowed, has once again raised the questions of Government aid for mines on the border line and of the greater encouragement that should be given to mining by both the Government and Labour. It is even suggested that the working of the mine should be continued at a loss by the financial help of the Government, as the amount of public money thus absorbed would probably be much less than that required to provide for the workless in the township of Benoni. In the meantime the position is being reviewed by Dr. Pirow, the Government Mining Engineer.

Cape Province.—The Manganese Corporation, which is developing deposits in the Postmasburg district, is parting with control to the Huelva Copper and Sulphur Mines, a French-owned company registered in London which has worked pyrites mines in Spain for many years. Mr. F. N. Pickett has been prominent in the handling of this manganese promotion and he is also a director of the Huelva company. The new arrangement provides for the purchase at par of 400,000 shares in the Manganese Corporation and the exchange of 65,000 Huelva shares for 32,000 additional shares of the corporation. To effect the purchase the Huelva company is increasing its capital by the creation of 580,000 ordinary shares of £1 each and 58,000 deferred shares of 1s. each.

Southern Rhodesia.—The output of gold during August was reported at 46,473 oz. as compared with 46,369 oz. in July and 50,611 oz. in August last year. The number of producers was 135. Other outputs during August were: Silver, 7,625 oz.; coal, 98,849 tons; chrome ore, 21,959 tons; asbestos, 3,916 tons; mica, 12 tons; iron, 525 tons; barytes, 62 tons; diamonds, 77 carats.

Encouraging development results have recently been reported from the Sherwood Starr gold mine. A winze on No. 8 level on the old ore-body has been sunk 96 ft., the ore assaying 38·5 dwt. per ton over 51 in. and the whole width has not been fully exposed. On the new ore-body the north drive on No. 9 level has averaged 36 dwt. over 86 in. for 30 ft. driven, while on the south drive the ore has averaged 50·1 dwt. over 87 in. for a similar distance.

Nigeria.—The London Tin Syndicate proposes to absorb the Northern Nigeria (Bauchi) Tin Mines, Ltd., the arrangement being that every two Bauchi ordinary and preference shares of 10s. each will receive one share in London Tin. These two companies belong to the Anglo-Oriental group and the reason given for the amalgamation is that London Tin will be better able to finance the duplication of the hydro-electric power station at Kwall Falls.

Australia.—The North Broken Hill company has purchased the Junction mine from the Sulphide Corporation. It will be remembered that the mine was bought by the latter company after the fire in order to keep the organization going during reconditioning, but the ore was not of sufficiently high grade to warrant a continuance of operations when the subsequent fall in the price of metals occurred.

The Wiluna Gold Corporation reports that further improvements in detail in the metallurgical process described in our issue of May of last year have been made whereby 1s. more per ton can be extracted at a cost of 6d. per ton less. This prospective increase of 1s. 6d. in the profit per ton is of considerable importance in that it brings the ore in the West lode well within the limits of payability. Arrangements have consequently been made for preparing this lode for stoping above the 290 ft. level. In addition it renders 250,000 tons of semi-oxidized ore in the East lode lying near the surface amenable to profitable treatment. Most of the mining work done during the past year has been on the East lode and has consisted of driving sub-levels and cross-cuts and sinking winzes. This work will facilitate ore extraction on the lines now adopted and in the meantime it has confirmed the estimates of ore reserves.

Malaya.—The Renong Co. reports a profit of £40,160 for the year ended June 30, as compared with £39,417 the year before, and has paid as dividends £3,750 on the preference shares and £23,496 on the ordinary shares, the rate being 17½%, as compared with 20% the year before. The output of tin concentrates was 654 tons, as compared with 500 tons.

The Ampang (Perak) Dredging Co. has come to the end of its financial resources, owing to the dredging returns being consistently lower than the estimates on which the company was floated. The board put forward a scheme for reconstruction, but did not strongly advise its adoption. At the meeting of shareholders held on October 1 a committee was appointed to consider the position and if it is unable to recommend any further provision of funds there will be no alternative to liquidation.

Burma.—The Burma Corporation reports the value of the Chinaman and Shan ore-bodies on the 9th level. Where the west cross-cut 1,389 ft. south intersected the Chinaman ore-body the total width of ore was 45½ ft. in three veins averaging 23·6% lead, 6·6% zinc, and 1·5% copper, and 17·9 oz. silver per ton; the west cross-cut 1,499 ft. south exposed a total width of 53 ft. of ore in four veins, averaging 22·2% lead, 4·8% zinc, and 9·5 oz. silver. The cross-cut at 379 ft. north intersected the Shan lode, where the width was 22½ ft. averaging 51·4% lead, 10·7% zinc, and 38·5 oz. silver.

The Mawchi tin and wolfram mines in the Southern Shan States have been worked by an English company for some years with varying success. The product is a mixture of ores, which is profitably treated by Murex, Ltd., but the company has hitherto had insufficient capital to maintain the reserves. Two years ago Consolidated Mines Selection, Anglo American Corporation, National Mining Corporation, and their associates provided adequate capital and undertook a plan of development recommended by Mr. W. H. Rundall. According to the report now issued, 135,879 tons of ore averaging 4·26% of combined tin and wolfram have been proved above the level of No. 1 main cross-cut adit and the ground to a further depth of 150 ft. is now in course of development. It is expected that milling will be resumed early in 1930, when 4,000 tons will be treated monthly for a yield of 160 tons of mixed concentrate. The first of the hydro-electric power plants recommended by Mr. Rundall is in working order and plans are in hand for erecting a second plant, on the completion of which the amount of ore treated per month will be increased to 6,000 tons.

Canada.—The Porcupine Goldfield Development and Finance Co. is to be placed in liquidation. This company was formed in 1923 by the National Mining Corporation and the New Consolidated Gold Fields, but the venture has been disappointing. Operations at the Ankerite, at Porcupine, have been suspended, and the Stemwinder, in British Columbia, has been sold.

Brazil.—In April last some particulars were given of the developments in depth at the St. John del Rey Co.'s gold mine. Since then the workings have been extended to the 26th horizon, 7,316 ft. vertically below outcrop, and cross-cuts are being driven to the lodes. On the 25th horizon investigations are being continued with the object of determining the value and relationship of the main and parallel lodes, which have both in places yielded high-grade ore, as is reflected in the monthly returns. Until more is known of these lodes the scheme for establishing a direct route to the bottom of the mine is postponed. A report on the mine made by Messrs. Graton and Bjorge has been received and is being closely studied by the board and management. The ventilation of the deep levels has been greatly improved lately and there is no difficulty in maintaining the labour force.

Mexico.—The Santa Gertrudis company has published information relating to current developments. At the Dos Carlos mine the developments have been better in the lower levels than was at first expected and it has been decided to sink deeper and open up the 23rd level. Lateral development is also being done, especially to the south and east of the Dos Carlos lode and to the north of the Ohio area, and the results in this direction have been good on the 19th, 20th, and 22nd levels. On these levels the silver content disclosed has been from 20 to 43 oz. of silver per ton.

In January it was mentioned in this column that the Fresnillo silver-lead-zinc mine, in Zacatecas, which has been financed and developed by the Mexican Corporation on a profit-sharing basis, was to be operated in future by the New York company which owns the property. Particulars of this reorganization of operations have now been published, from which it appears that the capital of the Fresnillo Company, of New York, has been rearranged and blocks of the new shares given to the Mexican Corporation. The management is now in the hands of the New York company, in which the Mexican Corporation holds the control. It will be remembered that in the upper levels the mine yields oxidized ores which are treated by cyanide for their silver content and that the ore changes to silver-bearing lead-zinc sulphides in depth. The cyanide plant is treating 70,000 tons per month of silver ore and the reserve of this class of ore is estimated at 2,300,000 tons averaging 6 oz. silver and 0·13 dwt. gold per ton. These figures include 600,000 tons of manganese-silver ore, which is being treated by the McCluskey process before cyaniding. The sulphide ore is treated by selective flotation, producing lead-silver and iron-silver concentrates, which are sold to local smelters, and zinc concentrates, which are shipped to Europe. The present capacity of the plant is 21,000 tons per month, and is being gradually increased. The positive and probable reserves are estimated at 511,467 tons averaging 10·5% lead, 11·7% zinc, and 0·6% copper and 11·8 oz. silver and 0·7 dwt. gold per ton. The main ore-shoot has been recently cut at the 425 metre level, where the ore is of higher grade than in the corresponding areas in the levels above. For the three months May to July following the reorganization of the Fresnillo Company the earnings amounted to $438,000 and a quarterly dividend absorbing $250,000 was paid on August 25.

Panama.—The Panama Corporation announces that Mr. C. J. Inder is now examining the alluvial gold deposits on the Sabalo River with a view to deciding on the plant required. It also states that at the Hatillos the lead-zinc deposit is developing satisfactorily, the lode being wide and the gold content high.

Derbyshire.—The Mill Close mine, for many years the largest producer of lead in this country and at which it was thought recently operations would cease because of the failure of the ore-body, is now in very active production. A new make of ore has been discovered and the output of the mine is now 150 tons concentrates per week and from the adjacent smelter 100 tons of pig lead per week.

Spain.—In the last issue some particulars were given of the progress made by the Tigon Mining and Finance Corporation, particularly in connection with the development of the elemental sulphur deposit. The company has since then obtained further working capital by the issue of 184,980 shares of 5s. each. Of these shares 92,000 are being taken at 22s. 6d. by a British group interested in the sulphur industry and 92,980 shares underwritten by the same group are being first offered to shareholders at 20s.

THE GEOLOGY OF THE GOLD COAST

By Sir A. E. KITSON, Government Geologist

This brief statement, together with the map, is based on Bulletin No. 2 of the Gold Coast Geological Survey, entitled "Provisional Geological Map of the Gold Coast and Western Togoland, with Descriptive Notes thereon"

The following table gives details of the geological formations on the Gold Coast and the map indicates their distribution. Owing to the limited occurrences (chiefly along the coast) of the Recent, Amisian, Apollonian, Sekondian, and Accraian deposits it has not been possible to indicate their occurrence on the map.

Recent.	Beach sands, gravels, laterite; alluvial gold, diamonds, tinstone, bauxite, manganese ore, iron ore, monazite.
Amisian. (Pleistocene ?)	Raised beaches.
Apollonian. (Cretaceous ?)	Clay-shales, mudstones, sandstones, grits, limestones; oil, bitumen, pottery and brick clays, pigments.
Sekondian. (Carboniferous ?)	Clay-shales, oil-shales, sandstones, grits, conglomerates, nodular limestone; sulphur, pottery and brick clays, pigments.
Accraian. (Bokkeveld ? Mid-Devonian ?)	Clay-shales, sandy shales, mudstones, sandstones, grits; brick and pottery clays, pigments.
Voltaian. (Waterberg ? Pre-Mid-Devonian ?)	Clayey, sandy, and calcareous shales, mudstones, sandstones, grits, conglomerates, lenticular limestones; banded hematite-sandstone, building stone, brick and pottery clays, pigments, barytes, silica, abrasives, refractories.
Akwapimian. (Potchefstroom ? Pretoria ? Pre-Mid-Devonian?)	Clayey and calcareous shales, mudstones, sandstones, grits, breccia-conglomerates, limestone, and chert, at places pressure-metamorphosed to slates, phyllites, schists, quartzite, hornstone; banded hematite-sandstone, building stones, brick and pottery clays, pigments, silica, abrasives, refractories, limestone.
Tarkwaian. (Witwatersrand ? Precambrian ?)	Slates, phyllites, flagstones, sandstones, sericite grits, conglomerates, and breccia-conglomerates locally metamorphosed into schists and intruded by dykes of red granite, porphyry, felsite, epidiorite, dolerite, etc.; banket and lode gold, hematite-quartzite, flagstones, brick and pottery clays, pigments.
Birrimian. (Swaziland ? Precambrian?)	Slates, phyllites, flagstones, sandstones, schists, quartzites, grits, conglomerates, hornfels, agglomerates, tuffs, lavas of rhyolite, dolerite, andesite, with intrusions of white, grey, and red granites and pegmatites, porphyries, aplite, felsite, andesite, dolerite, diorite, hornblendite, pyroxenite, gabbro, peridotite, serpentine, ortho and para gneisses of various kinds; lode gold, manganese, graphite, staurolite, garnet, kyanite.
Archæan. (Possibly Birrimian.)	Gneisses and schists of kinds indicated under Birrimian, with intervariations, granites, pegmatites, aplite, felsite, quartzite, marble; gold, copper, garnet, building stone.
Intrusives. Mainly Acid and Intermediate (Post-Birrimian) and *Metamorphics.*	White, grey, and red granite, pegmatites, porphyries, syenite, aplite, felsite, rhyolite, trachyte, andesite, etc. of muscovitic, biotitic, or hornblendic types, with intervariations, also belts of metamorphosed sediments; gold, molybdenum, tin, tungsten, titanium, monazite, kaolin, beryl.
Intrusives. Basic and Ultra Basic (Post-Birrimian) and *Eruptives.*	Peridotite, gabbro, picrite, dolerite, basalt, eclogite, pyroxenite, hornblendite, diorite; copper, platinum, nickel, asbestos, etc.

The country consists mainly of an upraised marine plain—forming much the larger portion—and several highlands. During the long period of elevation—a series of successive uplifts of the country—there has been great erosion which has swept away into the Gulf of Guinea as mud and sand huge masses of rocks and left numerous isolated hills and groups of them over the whole of the southern, western, and eastern parts of the country and round the borders of the plateaux. During the various stages of elevation these hills formed islands, solitary or as members of archipelagoes.

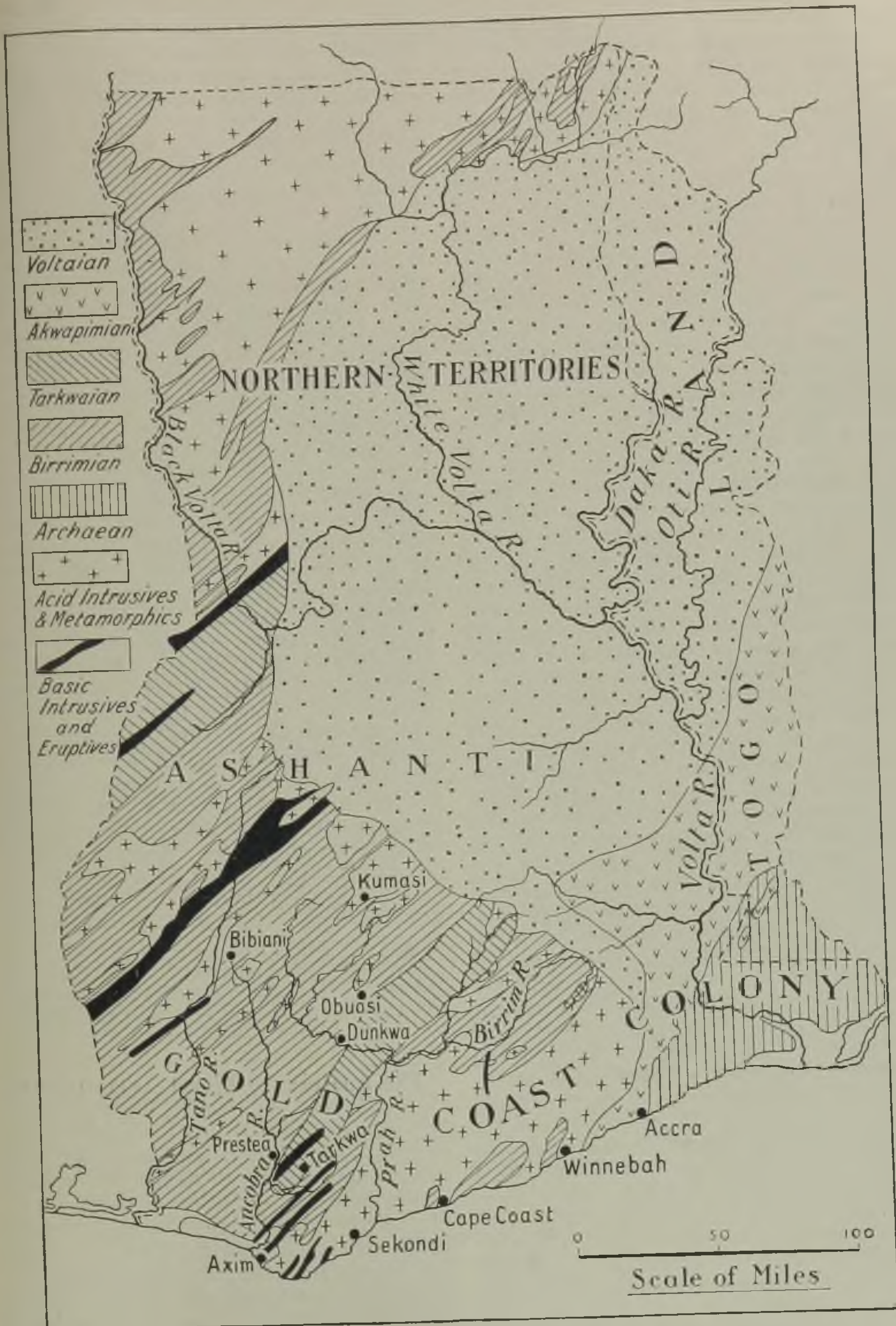
Large portions of the country are covered with a dense forest, in most parts of which there are very few outcrops of rocks, owing to the thick cap of soil due to tropical weathering. Many of the channels of streams show small exposures of rocks, but few of them have sections of value to illustrate the relations of the rocks. The geological evidence in the forest zone has been derived chiefly from sections along the coast, some streams, and a few railway cuttings. In the open and lightly timbered country, particularly in the western and northern parts of the Northern Territories, much of value has been obtained from large exposures of rocks. But all through the country there are blocks of scores, and even hundreds, of square miles in area of which the geology is unknown.

The geological formations comprise thick series of sediments, some of them with interbedded pyroclastic rocks (agglomerates and tuffs) and lava flows, others of them, younger in age, composed almost entirely of ordinary sediments. Into the oldest sediments there have been at different periods many intrusions of igneous rocks of acid, intermediate, and basic kinds, particularly acid, forming great masses of various types of granite of different ages. Around the peripheries of these granitic intrusions and for varying distances from them there has been much alteration of the sediments, due to contact-metamorphism. The rocks have partially or wholly lost their original character and become transmuted into crystalline rocks—quartzites, schists, and paragneisses of various kinds. There has also been much dynamic metamorphism by which both sediments and igneous intrusions have been completely altered into schists, paragneisses, and ortho-gneisses. So large a part has metamorphism played that it is now impossible to state whether certain rocks should be placed in the oldest known division of rocks, the Archæan, or in a younger one, the Precambrian. In deference to common practice, areas with rocks of these kinds have been marked on the map as Archæan, but it is not satisfactory to regard them as really older than those of other areas where field and microscopic evidence show that rocks definitely known to be extremely metamorphosed examples of sedimentary rocks of post-Archæan age have characteristics identical with those placed tentatively in the Archæan division.

For the classification of the rocks of the country it has been necessary to group them in systems, with names based upon those of natural features or places where they are found. One of the prominent features of the geology is the paucity of fossils of identifiable character. So far as known these occur at four localities only, namely, in descending order of age, (1) the oldest, at Accra (Mid-Devonian); (2) in coastal cliffs east of Sekondi (Lower Carboniferous?); (3) at Takoradi (Upper Carboniferous?); and (4) in Western Apollonia (Cretaceous?). Thus it will be noticed that there are no deposits recognizable as early Palæozoic, none of early or middle Mesozoic, and no Kainozoic (Tertiary). In order, therefore, to assist in some measure in a comparison with deposits in other countries an attempt has been made to correlate the Gold Coast rocks with those of the Union of South Africa, by adding the South African name to either or both the local and European ones. Thus the Accraian System (Mid-Devonian) is correlated provisionally with the Bokkeveld of South Africa.

A noticeable feature of the disposition of the strata is that all those of pre-Middle Devonian periods are folded along lines mainly N.E. and S.W. and show moderate to high dips to N.W. and S.E., while those younger than Middle Devonian are normally flat-bedded, or have low dips. Along lines of fault or crushing, however, the latter rocks show high dips or local folds and contortion—at some places to a considerable extent—broadly parallel with the general N.E.-S.W. foliation of the older rocks. There appears to be evidence that folding of the Birrimians along these lines took place before the Tarkwaian period. The folding of the Akwapimians was certainly before the Accraian period, for though the Accraians show slight folding and faulting along N.E.-S.W. lines, this is far too feeble to have been synchronous with the movements that affected the Akwapimians, for both systems of rocks are in the same affected belt. Besides, rocks of these systems occur in faulted association at Accra and show unmistakably the greater age of the Akwapimians. Thus it seems that folding of the Caledonian type operated over wide divisions of time. On the evidence of folding and faulting it appears, therefore, that the Akwapimians are at least pre-Lower Devonian, and possibly much older. Though the main folding of the country is probably Caledonian there are certain areas, where the folding is E.-W., and may, perhaps, be attributed to Armorican movements rather than to the distortional action of intrusive granite.

The Archæans occurring in the south-eastern corner of the map (the eastern portion of the Colony and southern portion of Western Togoland) show great resemblances to the nearly or completely metamorphosed portions of the Birrimians. On the plains N.E. of Accra these Archæans comprise biotite-gneisses and hornblende-gneisses, of both ortho and para types (many of them highly garnetiferous), biotite-hornblende-gneiss, tremolite-marble, quartzites, quartz-schists, and quartz-mica-schist. Intrusive into these are granites, pegmatites and aplite, porphyry, diorite, dolerite, etc. The steep isolated hills and short ranges that were islands during the various stages of elevation of the country now stand as silent monuments testifying to the failure of the ceaseless efforts of a tropical climate and



Geological Sketch Map of the Gold Coast and Western Togoland.

the attacks of the Atlantic to reduce them to the uniform level of a typical marine plain.

The Birrimians have a very wide distribution over the Gold Coast. They occur in the N.W. corner of the Northern Territories, and may be seen, though not continuously, southward to the coast, and eastward to near Winnebah. In the north they extend north-eastward, visible at intervals in a broad expanse of gneiss and granite nearly to the N.E. corner of the Northern Territories. In the Colony and Ashanti they extend north-eastward for unknown distances under the great overlying masses of the Voltaian System. Among the granitic rocks, there are many strips of para-gneisses and mica-schists which were originally Birrimian sediments, and doubtless there are many other strips, where, but for the masking cap of soil and the absence of outcrops of rock, they would be visible. They are repeatedly folded and must be many thousands of feet thick, but the thickness has not yet been ascertained. They contain the gold lodes of fissure type and the auriferous pegmatites and associated quartz masses and reefs genetically connected with the granitic intrusions. The belts of graphitic and manganiferous phyllites and schists in them afford good data for correlation.

The type locality of the Tarkwaian System is the Tarkwa-Abosso goldfield. There it consists of a series of coarse and fine sediments, which have been grouped into five main divisions,[1] in descending order, conformable sequence, and thickness, as follows:—Dompim quartzites, 1,000 ft. Dompim phyllites, 500 ft. Huni sandstones, 1,500 ft. Tarkwa phyllites, 800–1,000 ft. Banket series, 2,100 ft. Some of the last-named are auriferous, similar in many respects to the banket of the Witwatersrand, Transvaal.

As will be seen from the map igneous rocks, with their associated metamorphosed sediments, occupy a large portion of the country. The oldest of these rocks so far as known is a dark biotite-granite, of medium texture. This has a wide distribution and is intrusive into sediments of the Birrimian System. Genetically connected with it is biotite-pegmatite. Neither has been definitely proved to be specially associated with minerals of economic value. The next in age is a muscovite-granite, also intrusive into the Birrimians, but not the Tarkwaian, so far as known. This granite occurs at various places from the coast to the northern end of the Northern Territories. Dykes of pegmatite and aplite, with their acid terminals and associated veins of quartz, contain gold, pyrite, cassiterite, molybdenite, wolfram, löllingite, rutile, etc., and are distinctly connected with the granite. This muscovite-granite varies a good deal, and can be seen in its pure form, but also as a biotite-muscovite-granite, or a muscovite-biotite-granite, where it has assimilated part of biotite-granite or biotite-schist intruded by it. The next in age is the red granite of very wide distribution through the country. This rock varies greatly and may be seen as hornblende-granite, quartz-diorite, porphyrite of various kinds, and porphyry, of various shades of green, red, terra cotta and grey, due to the saussuritization of some of the felspar. Much of this type of granite is coarsely porphyritic. Genetically related to the red granite are red pegmatite and porphyries of various kinds. Some of the dykes of pegmatite and aplite connected with this red granite contain a good deal of pyrite, probably auriferous, for gold can be obtained from their detritus by panning. Of the ultra-basic rocks there are large and small dykes of pyroxenite and hornblendite, with variations, eclogite, picrite, and serpentine. Some of these rocks contain a little copper sulphide, and analyses have proved nickel and platinum also in small proportion. As already mentioned under the Birrimian System, there are great masses of inter-bedded dolerite and andesites. Dolerite also occurs as necks and dykes of early Voltaian or late Akwapimian age. Some of them are olivine-bearing. There appears to be evidence also of the intrusive character of some andesite. Rhyolite has been found, apparently interbedded with the Birrimians, though perhaps intrusive into them, in Western Ashanti. Trachytes are rare; they are highly chloritized and carbonated.

[1] "The Tarkwa-Abosso Goldfield," Memoir No. 1, Gold Coast Geological Survey.

The Institute of Metals.—The Institute of Metals has just issued its programme for the coming Session. The subjects dealt with are of a practical character, and include papers on "Metals in Aircraft Construction"; "Metal Melting by Electricity"; "Chromium Plating"; "Some Difficulties in Aluminium Alloy Founding and Some Remedies"; "Electric Heat-Treatment Furnaces"; and "The Effect of Some Impurities in Copper." Programmes can be obtained from the Secretary, Mr. G. Shaw Scott, M.Sc., 36 Victoria St., London, S.W. 1.

THE TESTING OF ALLUVIAL TIN DEPOSITS

By W. L. H. MORRISON, A.Inst.M.M.

The author describes a number of common sources of error in hand-boring for the testing of alluvial tin deposits, and pleads for greater accuracy in connection with the estimates of contents of low-grade tin deposits.

Owing to the extent to which capital is being invested in the dredging of alluvial flats for tin ore, and because, with gradual depletion of high-grade areas, lower and yet lower grade propositions are being considered, it becomes increasingly important that the valuation of such deposits by boring should be carried out with greater accuracy than has been required in the past.

When the metal was at a low figure and 1 lb. per cu. yd. was a minimum for profitable working, an error of 0·1 lb. represented only 10% of the total value and thus came within the margin of safety allowed for. Now, however, that 0·4 lb. ground is considered workable such an error in the weight of the sample would represent 25% of the total, which is far too high and may mean the difference between profit and loss.

It seems certain that, with the steady depletion of tin areas, the price of the metal will rise to greater and greater heights. With each rise lower and still lower grade areas will be exploited, and greater and still greater accuracy will be necessary in the valuation of properties.

The present drop in the price of the metal is merely a temporary set-back, due to the abnormal number of dredges started on low-grade areas in response to a rise in price of the metal. These dredges have temporarily caused an over-supply, but it must be remembered that their life is short. According to the statistics gathered by the Inspector of Mineral Ores, Federated Malay States, and published in his monthly Bulletin for February, 1928, the following table represents the number of dredges operating in the Federated Malay States and their approximate life.

No. of Companies.	Total No. of Dredges.	Estimated Life. Years.
4	9	over 30
6	12	25 to 30
11	17	20 to 25
11	27	15 to 20
29	35	10 to 15
12	16	5 to 10
3	3	less than 5

Averaging the above results we get 119 dredges with an average life of 17 years. To maintain the present output it will be necessary to start another 119 dredges every 17 years, or a great many more, as the new ones will presumably be in lower and still lower grade ground. The prospect of starting more than 7 dredges per year in the Federated Malay States seems hopeless, so that a gradual fall in output seems certain.

With lower values becoming workable, meticulous accuracy will be necessary in valuing areas. At present the methods used

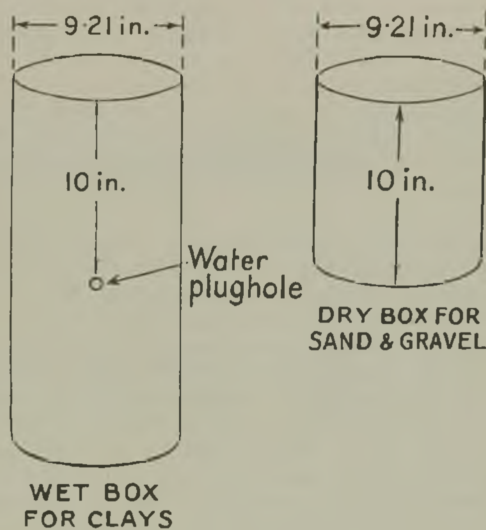


FIG. 1.—EXPLANATION OF WORKING.—Water is put in the wet box until it flows from the plug-hole. The plug is then inserted. Clay is broken into lumps and dropped into the box. When all has been put in, the distance of the surface of water from the top of the box is measured and subtracted from 10, thus giving the number of inches of solids. Suppose 2 in. were empty, giving 8 in. of material, the sample was washed and weighed, giving 75 grains of tin oxide. In the field book we put in column headed " value " 0·75. As, however, this was obtained from $\frac{8}{10}$ths of a box it is clear that more would have been obtained from a full can. To arrive at full can value we multiply by 10 and divide by 8 giving 0·94 lb. per cu. yd. As there were 5 ft. of this section we multiply this value by 5 to get 4·70 ft.-pounds. The dry box is used in the same way but without water, and on measuring sand and gravel only.

are very rough and ready, and every engineer works on a different system. Some engineers state that as boring only gives an approximation of the value of the ground, meticulous accuracy in arriving at the value of individual bores is unnecessary, and is a sheer waste of time. It seems to me that this is a dangerous doctrine, and is likely to encourage carelessness. The average value of a property is arrived at by averaging the results obtained from a large number of systematically placed bores. Assuming sufficiently close boring, such averaging is pure mathematics and by the functioning of the Law of Probabilities the average so obtained will be dependable, provided only that the individual bore results are dependable. The more accurate the individual results, the more accurate the general average.

I would suggest that the value of a sample weighed should never be subject to an error of more than 10%. Now if areas going 0·3 lb. per cu. yd. are to be worked it is clear that the limit of error will be 0·03 lb. per cu. yd., which is a degree of accuracy which is not being attempted at present. The old rough and ready scales which gave results to the nearest 0·07 lb. per cu. yd. will have to be scrapped and far more delicate balances used. Chemical balances reading in grains will, of course, give the greatest accuracy.

Using a can of 666·5 cu. in. capacity (Fig. 1), it is clear that a sample weighing 100 grains from such a can full represents 1 lb. per cu. yd.; 50 grains = 0·5 lb.; and so on; one grain then represents 0·01 lb. per cu. yd. Using a can of these dimensions calculation is simplified, and great accuracy is obtainable. The advantage in using a can of 10 in. in height is that every inch in height represents $\frac{1}{10}$th of a can, so that when a can is only partly filled, the percentage of full can is quickly found by measuring the number of empty inches and subtracting from 10.

For ease in transport a small beam balance has a great advantage, and it would be easy to construct one giving results to the nearest grain (that is to 0·01 lb. per cu. yd.). The beam would be divided into five major divisions each representing 100 grains. These would be subdivided into 10 smaller divisions representing 10 grains each. The balance weight would swing from a sliding bar engraved as a vernier, and on this vernier readings would be to the nearest grain. A rough sketch of the proposed balance is shown in Fig. 2.

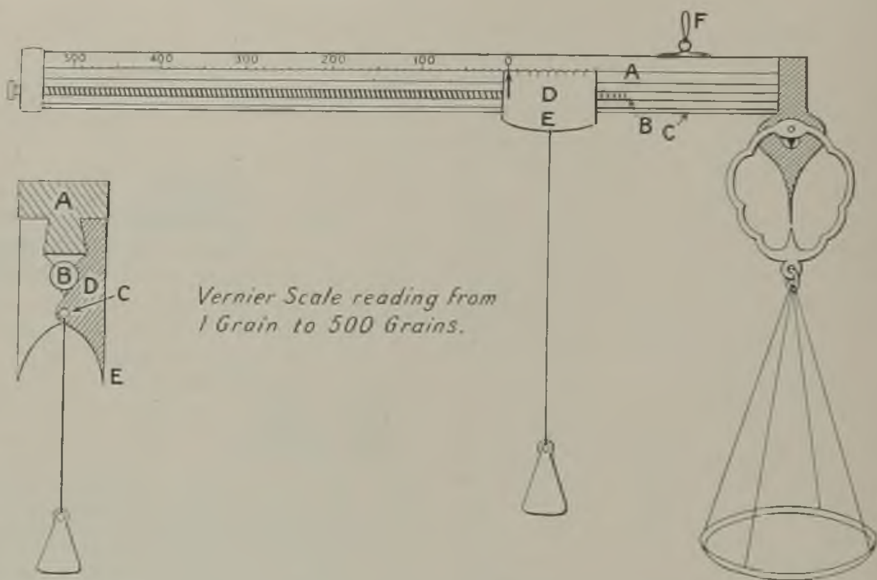


Fig. 2.—Elevation and Cross-Section of the Morrison Scale. A, beam. B, Screw actuating D for micrometer movement. C, Spindle on which D moves. D, Vernier with balance weight suspended. E, Lever points which when depressed disengage D from B, allowing free quick motion along C. F, Thread on which balance is suspended by hand. When used with a measuring can 10 in. high by 9·21 in. diameter, 100 grains = 1 lb. per cu. yd. 50 grains = 0·5 lb. per cu. yd. 1 grain = 0·01 lb. per cu. yd.

Apart from the question of accuracy in weighing samples there is the matter of the different systems of calculation, and it is surely time that these systems were examined by a responsible body and one system laid down as the officially approved system. In general there are two main system groups:—(1) Wherein the material raised is not measured and the sample obtained is applied to the theoretical cubic content of the bore-hole; (2) wherein all material raised is measured in measuring boxes, and the sample obtained is applied to such measurement irrespective of the theoretical content of the hole. In the following notes I will attempt to show that the second system is the only dependable one.

If it is accepted that the measurement of material raised gives a more dependable basis of calculation than theoretical core content, there still comes the question as to what correcting factors or coefficients, if any, should be applied.

The values shown by the box measurement system, which is the prevailing system in the Federated Malay States, are subject to slight error, but this error is not constant. The error in clay is very small, while the error in pebbly wash may be great. To apply a constant factor, such as the Radford, Banka, etc., for correcting an error which is not constant is obviously fallacious.

In the following notes I attempt to show that, when the actual boring work is properly carried out, the error in clays is very small and almost negligible. The error in loose pebbly wash is material, and for this reason a factor which would be correct for clays would be wrong for such pebbly wash, and *vice versa*.

Apart from the two factors for correcting values in clays and gravels, there will be a third factor for arriving at probable recovery. This factor cannot be laid down by any hard and fast rule, and the examining engineer must form his own opinion as to probable recovery and he will state this in his report. He will, of course, be guided by many points, such as nature of ground, friability, nature of bottom, presence or absence of boulders and sunken timber, quantity of clean water available for washing purposes, method of mining, etc.

One occasionally hears it stated that in practice dredges usually recover more than the values shown in the boring report. This is in itself proof that boring systems in the past have not given accurate results, and the need for greater accuracy is obvious. In the case of a dredge recovering more than boring values it would seem that either the prospector worked on an ultra-conservative system, or lacked skill or care in calculating values. In the case of a dredge recovering less than the bore results, the system used in boring may have been at fault, the prospector may have lacked skill or care in calculating his values, or the dredge may have worked inefficiently. The latter point can be determined by boring the tailings.

When boring in true alluvium we thus have two possible sources of error:—(1) the system used, and (2) the skill and care in carrying out the work. Where there are two possible sources of error it is difficult to fix the blame when recovery does not come up to expectations. If a standard system were adopted, the sources of error would be reduced to one, namely the care and skill of the prospector and his ability to draw sound conclusions from the data at his disposal.

Many years ago most boring results in the Federated Malay States were calculated on the cubic contents of the bore-hole. Some took the outer diameter of the pipes, some the inner, and some the edge of the cutting shoe. This system almost always gave an under-estimate of values, and probably gave rise to the theory that dredge recovery is always greater than boring results. Later on this system was generally abandoned in the Federated Malay States in favour of one wherein all material raised was measured either in a dry box or in a water-displacement box, and the values of the different strata calculated from the values obtained from such representative samples. It was found that the material so measured always amounted to considerably less than the theoretical quantity as calculated from the cubic contents of the pipe.

There are still some prospectors in Malaya who follow the cubic content system, and some who, while following it, also measure all material raised. At every section they compare measurement with theoretical content and make such adjustment as they think necessary when a great divergence occurs. Theoretically the core should be determined by the diameter of the shoe at its cutting edge. This edge being bevelled, all material outside the edge will be compressed and forced outwards; all inside the edge will be compressed and forced up inside the pipe.

Using my own system, which I will refer to later, I find that when working in clays, using alternately auger and sand pump, and cleaning the pipe out thoroughly at each section, I obtain by water-displacement measurement a very close approximation to the theoretical cubic content as fixed by the cutting edge of the shoe, but, when working in sand or pebbly wash, the quantity raised is very materially less than such theoretical figure, sometimes less than half.

Mr. J. B. Scrivenor, in his "Notes on Prospecting for Tin Ore in Federated Malay States," points out that when taking out a core in stiff clay with an auger, 288 cu. in. was raised for every 2 ft. in depth, whereas the cubic contents of the interior of the pipe would give 471·24 cu. in. per 2 ft. He suggests that the diameter of the auger gives the true dimensions of the core. He quotes Mr. D. H. Bannerman as suggesting that the remaining 183·24 cu. in. was compressed and pushed out by the bottom of the pipe as it progressed. Without details of the method followed it is hard to draw conclusions from these results. When using the auger alone no definite measurement can be arrived at. The auger is probably tapered and thus removed a tapered core. The auger leaves a lining of clay around the inside of the pipe which may break down at haphazard intervals. When the auger is withdrawn a certain amount of clay may slip off and drop back into the pipe. If auger and sand pump are used alternately and the pipe is cleaned out at each section there should never be such a discrepancy when working in clay.

The cutting shoe will not force away material that lies inside the cutting edge, but if the pipe were driven too far ahead of the tools the tough clay would jam inside the pipe, converting it into a solid column. This will certainly force away clay from the bottom of the pipe if driven further. Perhaps this is the explanation of the discrepancy quoted. If the pipe is always kept just ahead of the tools there is no internal resistance to the core and a full size core should be obtained. When such conditions are complied with and the box measurement falls much below theoretical content in clay, I would suspect that the measurement was wrong.

A great source of error in measuring clay and sandy clay lies in the fact that the sand pump breaks up a large proportion of the clay into slime and muddy water. The auger draws a firm sample, but loose broken fragments drop back and when the pipe is screwed down a shaving of clay rises in the pipe. Usually the pipe contains water, but if not, water is added to facilitate work with the sand pump. The sand pump cleans out the pipe to the depth of the section being sampled, but in doing so slime and muddy water are formed. The sand pump brings up this mixture of clay and water with some solid lumps of clay as well. The measurement of the solid portions of the clay in a water-displacement box is a simple matter and leaves no room for error. The estimation of percentage of solid in the slime and muddy water is less straightforward and is a common source of error.

Some prospectors put such slimes into a tub, add clear water till the sedime n settles, pour off surplus water, and measure the sediment, regarding this as the amount of solids. This is sheer guesswork and can hardly be expected to give correct results. Some prospectors put such slime into bags and leave it over night to drain, measuring and washing it after all water has filtered out. This method should yield correct results, but it is open to the great objection that it prevents washing and dressing samples on the spot while under the eye of the engineer. It therefore opens up a chance of salting.

Some prospectors use cooking pans and cook this slime at the bore site till it reaches the same consistence as the auger sample. This gives excellent results but is somewhat troublesome. I have followed this system even when boring in mangrove swamps and when boring in the sea from sampans, but it cannot be used when boring ground the surface of which is flooded but where the water is too shallow for the use of sampans.

Failing the cooking pan method I adopt the following method, and the results are instructive :—Solid core is raised by the auger and the remainder by the sand pump. The solids raised by the auger and such solid lumps as come up in the sand pump are squeezed out by hand to remove any slime clinging to them. These solids are measured by water displacement and the measurement recorded. They are then puddled with plenty of water and all clay removed leaving only sand, and pebbles if any. This sand is then measured and by this means the ratio of insoluble solids to the whole is determined. The slime is allowed to settle and the sediment is then measured, washed to sand, the sand measured, and measurement recorded. In every case

I find that the sand percentage obtained from the slime is greater than that obtained from the solids. I take this to prove that the slime, in spite of added water, is still less in bulk that when it was *in situ*, and I therefore correct the measurements accordingly, as follows :—

	Measurement in tenths of $\frac{1}{4}$ cu. ft. box.	Measurement of sand in tenths of $\frac{1}{4}$ cu. ft. box.
Solids	10	2·5
Slime	8	3

As the result from the solids shows that the true sand percentage is 25% I alter the result above to :—

Solids	10	2·5
Slime	12	3
	22	5·5

From this it will be seen that those who add water till the solids settle, pour off the water, and measure the sediment as solids are thereby increasing the error that already existed. This method can only be adopted in sandy clay, pure clay having no sand content. In pure clay having not a trace of sand, it is doubtful whether tin ore will ever be found. If tin ore were present in such clays it would be necessary either to work on the theoretical content of the pipe or adopt the following system, which I have sometimes used. The slime is measured in the field and the measurement recorded in the field book. It is well mixed up to render it of even consistency. A small receptacle such as a cigarette tin is used and a full tin is taken of this mixed slime. This is put in a small calico bag and labeled and tied up. These bags are taken back at the end of the day's work, cooked to the normal consistency of clays *in situ*, remeasured, and the percentage of loss in each case recorded. The field measurements of slime are then reduced proportionately. Generally speaking it will be found that the total of clay raised will come to slightly less than the theoretical content of the core. This is probably accounted for partly by the compression exercised on clay by the bevel edge of the cutting shoe and the auger, also by the quantity of clay that remains in suspension in the water inside the pipe.

An objection to the cooking pan method is that it causes the material to expand, but this expansion will only just about compensate for the loss of material in suspension. I have found that when working in clays, using the cooking pan method, the sand percentage method, or the slime sample bag method, measuring all material raised by water displacement, the quantity of material raised closely approximates the theoretical content of the core as determined by the cutting edge of the shoe, provided always that the pipe is kept just ahead of the tools, and that the pipe is thoroughly cleaned out at the end of each section for which the measurement is being recorded.

As regards measurement in sand, when working in a layer of sand it will usually be found that the material raised is less than the theoretical content unless the pipe is kept well ahead of the sand pump. The battering action of the sand pump forces the sand away at the mouth of the cutting shoe. It is therefore necessary when working in sand to drive the pipes as far ahead as possible before removing the core with the sand pump. Sand having no clay to fill the interstices should not be measured in a water-displacement box. The displacement box will give the total measurement of the actual grains of sand, making no provision for the interstices that existed *in situ*. Sand well shaken down in a dry measuring box will settle as compactly as *in situ*. The use of water displacement for measuring sand is a common error and results in inflation of values.

When working in rising sand a great excess of material will be raised, but if all is measured, washed, and the values reduced to full box value, no great error should result. In this class of ground the pipe should be driven as far ahead as possible. Those who work entirely on theoretical content will be "all at sea" in rising sand.

When working in a pebbly wash it will almost always be found that the material raised is very much less than the theoretical core content, sometimes less than half. The material can only be raised by the sand pump, and the percentage of pebble makes it necessary to batter with tools in order to force the material up into the sand pump. This battering action forces sand and pebble out through the mouth of the pipe. Even when the pipe is driven as far ahead as possible and pebbles are pulverized with a chisel before using the sand pump the same thing occurs though perhaps to a slightly less extent. The pipe when being screwed or driven down will also force pebbles away from the mouth of the pipe.

Those who calculate entirely by the cubic content of the pipe will be quite at fault when valuing this stratum. The material raised being much less than their theoretical figure, they greatly underestimate the values. As this is the stratum wherein lies the best of the ore, it is essential that it should be accurately valued. In this material the cubic-content system fails.

When working by box measurement this forcing away of part of the material would not matter if the small amount raised were representative of the whole, for then it would be merely a matter of calculation to arrive at the full box value, and thus the value of the stratum. Unfortunately the sample raised is not representative. The cutting shoe pushes stone away and sand slips in to take its place, and the sample raised will thus have an undue percentage of sand to pebble. As the pebble contains no ore, and the sand contains it all, it is evident that the raised sample is richer than the average of the section. This is, I think, the greatest source of error in boring, and it is hard to see how it can be corrected except by rough estimation. If it were possible to sink a shaft beside one of the bore-holes a comparison between the true value of pebbly wash as shown in the shaft and the false value shown by bore result would give a factor of error which could be applied arbitrarily to all similar bores.

Sometimes a large pebble gets in the way of the pipe and prevents material entering the pipe. The chisel merely forces this pebble down and it will not crack till it meets another large pebble below. The chisel will then succeed in breaking it. While it is being forced down no material enters the pipe and thus no sample is taken for that section. If this bore is in the midst of good values, it should be re-bored.

When working out the values in sand or pebble strata, it is a mistake to divide them into sections. All material for that particular stratum should be added together as one sample. The reason is that the flogging action of tools on loose wash causes a concentration at the bottom of such layer. If the quantity of material raised at the lower limit of this section were below the average, unduly high values would be recorded, as for example :—

Depth. Ft.	Quantity. $\frac{1}{4}$ Cu. Ft. Sections.	Value. lb.	Full Box.	Ft. Pounds.
20–25	1·5	0·60	0·40	2·00
25–30	1·2	0·84	0·70	3·50
30–35	0·4	0·80	2·00	10·00
				15·50

This should read :—

20–35	3·1	2·24	0·722	10·83

When a large boulder is met with it is frequently necessary to offset and re-bore in order to reach bedrock. If this occurs frequently the engineer should make allowance for the probable yardage occupied by the boulder and reduce his values accordingly.

It is the usual custom to take samples at each 5 ft. of depth, but whenever there is a change of strata the sample must be closed no matter what the depth, and a new sample started for the new stratum. In no circumstances should material from different strata be mixed in one sample.

In another method sometimes adopted, the pipes are driven to bedrock before any core is removed. It seems to me that this might result in serious error. The pipes having passed through tough clay, this will form a solid plug inside the pipes offering great resistance to the entry of further material. If such choked pipes are driven down through soft sandy clays or through sands and gravels, it seems certain that these, instead of entering the pipe, will be pushed away by the solid plug inside the mouth of the pipe.

I have heard that some engineers cook all material till quite dry and then weigh it instead of measuring. They contend that a cubic yard of rock or rock fragments always weighs the same if quite dry, whether of igneous, sedimentary, or metamorphic origin, and whether rock, sand, gravel, pebble, or clay. I have never tested this theory, but it does not seem to agree with Molesworth's weights of different rocks. In any case I do not see why weighing should be preferable to measuring even if accurate.

I will now discuss the water-displacement box : there are several different types in use but they all work on the same principle. In one the box is divided from top to bottom into 13 or 15 divisions each representing one tenth of a $\frac{1}{4}$ cu. ft. A dipper measuring also one tenth of $\frac{1}{4}$ cu. ft. is used with it. A couple of dippers full of water are first placed in the box. The material to be measured is then dropped in in small fragments. Should the water level fall below the surface of the material, another dipper of water is added, and so on until all material has been disposed of. The mark to which the water has risen less the number of dippers of water added then represents the measurement of the material.

I have seen some prospectors put all the material in the box first and then add dipper after dipper of water till the water rises above the surface of the material, occasionally prodding the material with a stick to ensure that the water shall find its way into all interstices. This is a slipshod way and there is no guarantee that all crevices will be thus filled by water. My objection to the use of this dipper system is that the prospector's attention may be distracted and he may lose count of the number of dippers of water used. It brings in an unnecessary source of error.

Another type of box measures $\frac{1}{2}$ cu. ft. Half way up the side a hole is drilled and fitted with a plug. In use water is first put in till it flows through the plug hole, and the plug is then inserted. The box then contains $\frac{1}{4}$ cu. ft. of water. The material is then added, causing the water to rise in the box. When all material has been added the point to which the water has risen represents the measurement of solids. The top half of the box, which measures $\frac{1}{4}$ cu. ft., is sometimes divided into 10 sections marked by nails or studs. I prefer to use a measuring stick the same length as the height of the top section of the box. This measuring stick is divided into 10 equal sections each representing a tenth of a $\frac{1}{4}$ cu. ft. This is cleaner, and saves fumbling inside a muddy box to locate nails or studs that have been obscured with clay. With the measuring stick I measure from the surface of the water to the top of the box and subtract from ten, which gives the measurement of the solids in the box. This double size box with plug hole is foolproof ; even a coolie cannot well make any mistake when using it.

The pipes should be thoroughly cleaned out at the limit of each section for which values are calculated. If this is not done, then when tools are again used to bore the next successive section, fragments belonging to the previous section will be mixed with the section being tested.

All sandy clays and all sand and gravel must be washed up. Some prospectors take a handful of clay, wash in a coconut shell and if they fail to find any ore they throw away all similar clay without washing. This is absolutely wrong. Wherever there is a trace of sand in the clay it must be washed. A small lump in a coconut shell will not prove anything. Some prospectors again merely take enough material to fill one measuring box and discard the rest, contending that one box full of representative material gives sufficient data for calculation. This is true, but there is no guarantee that the sample taken was truly representative of the whole.

Apart from the foregoing source of error due to faulty measurement of solids, the greatest source of error lies in salting. Every operation should be under the eye of the engineer from start to finish. The engineer who allows material to be carried out of his sight to be washed in a stream or pond is asking for trouble, and deserves to get it. A large tub should be installed at the bore site for washing samples. A coolie will be engaged to keep this filled with water. Another tub is used for puddling clays. The sample material, having been measured, is puddled and all clay washed out. The remaining sand and pebble, if any, is measured ; this sand and pebble is then washed in a pan or dulang to a concentrate. This concentrate is then fine dressed to separate tin ore from heavy impurities (amang). The tin and amang are then placed in separate metal saucers and dried. If there is no sun they will be dried by a small fire or lamp. Once dry they are packeted and labelled by the engineer who takes possession of them and takes them back with him to camp for weighing.

If all operations are carried out in this way under the eye of the engineer, there will be no danger of salting, unless the engineer is culpably unwatchful.

After the samples have been weighed they should be bulked for assay. For this I recommend that the bores be divided into classes and that the ore and amang of each class be assayed separately, and each subjected to correction according to its own assay.

1. High value bores with little amang.
2. High value bores with plenty of amang.
3. Medium value bores with little amang.
4. Medium value bores with plenty of amang.
5. Low value bores with little amang.
6. Low value bores with plenty of amang.

There will be thus six different grades of ore each with its respective amang, altogether

12 samples to be assayed. If it is not desired to make so many grades, at any rate all poor bores which border on the danger line should be bulked separately from good bores. These poor bores may be so reduced by assay that they are unworkable, and if on the fringe of a payable area they may be deleted. If they were bulked with good bores, a higher average assay might result which would indicate that they were workable. In this way unworkable bores which should have been deleted would be brought into the working area.

Having learned the assay of the ore sample, the field values are all corrected to correspond with a standard assay, usually 72%. The amang from each bore having been weighed, the same as the ore sample, the ore shown to be present in this by assay can then be calculated in terms of lb. per cu. yd. of 72% assay, the same as from the ore sample. This result from amang is added to the result from ore in arriving at the final value.

If samples are weighed with patent calculating balances or scales it is necessary before using such that they be carefully tested. The designers of these scales no doubt designed them correctly, but there is no guarantee that those subsequently sold by traders will be equally correct.

Having calculated the true value of the bores the engineer will estimate the value of the selected area as a whole, making due provision for the presence of boulder, pinnacle, sunken timber, etc. If the bottom is soft he will have to allow for the dredge digging a small distance into the bottom, as in actual work the dredge cannot work exactly to the surface of the bottom. The dredge must cut and bring up a bit of bottom before the man in charge can be sure that the bottom has been reached. If the bottom is hard, allowance must be made for the inability to clean it up. This loss will be much greater if the bottom is uneven or pinnacly.

The engineer will also estimate working losses and thus arrive at the probable working recovery and the output of the mine. In this he will take into consideration the method of working and the nature of the ground. If the ground is to be dredged, all values found in tough clays will have to be greatly discounted, as there will be poor recovery by dredge in such ground.

Reverting to boring operations, great care must be exercised in ascertaining whether the true bottom has been reached or not. Many cases of false bottom occur and many cases are on record where a boulder layer has been mistaken for the bottom. If there is any room for doubt it is advisable to sink an occasional bore well into the supposed bedrock to make sure. Some prospectors contend that they can always recognize decomposed granite, and hold that it is folly to bore into such. As against this argument I would quote Mr. J. B. Scrivenor, who in his pamphlet previously referred to says : " In some cases so great is the resemblance between a weathered granitic rock and a detrital bed that the only satisfactory test is the presence or absence of veins. . . . The only sure way would appear to be to prospect by means of pits which would enable the prospector to see any veins in section."

Limestone can usually be recognized and an acid test will make certain, but it should be remembered that limestone floaters do occur at some distance from limestone hills.

A sample page of a field book, Table I, is appended to show the method adopted in calculating values by the box measurement system. It shows the ruling off at change of strata, the calculation of solids in slimes by sand percentage, and the extension of values in foot pounds. The column headed " Value of Sample " means the value in lb. per cu. yd. that would have resulted if a sample of this weight had been obtained from exactly $\frac{1}{4}$ cu. ft. As the material usually is greater or less than one full box ($\frac{1}{4}$ cu. ft.) such a value must be reduced or increased proportionally in order to give " Full Can Value." The full box value multiplied by depth of section in feet equals foot-pounds and is put in this column. Total foot-pounds divided by total depth in feet gives average top to bottom value in pounds per cu. yd. In the example is shown the theoretical content for comparison, amang value of bore, assay of both ore and amang, and correction of values to correspond with standard assay of 72%.

Apart from errors in calculating values of individual bores, there are errors in calculating average depth and values of property from the bore figures, and errors in estimating areas, depths, and values due to boring too widely. Widely spaced bores on a pinnacly bottom may give a completely wrong idea of average depth and value. Certain bores, instead of cutting through pay wash at right angles, traverse this layer obliquely thus giving an exaggerated idea of the thickness of such a stratum. If the majority of bores penetrate into crevices between pinnacles an exaggerated idea of average depth will be given. In Fig. 3 bores *a*, *b*, *c*, *d*, *e*, and *f* are equally spaced across a valley. Four out

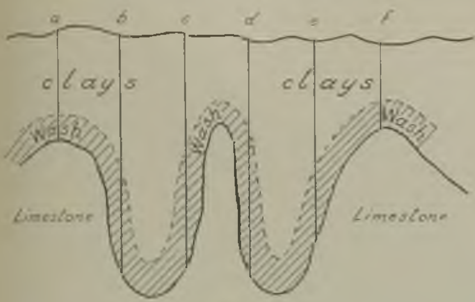


FIG. 3.

of the six (*b*, *c*, *d*, *e*) go to abnormal depth and cut karang obliquely and only two (*a*, *f*) show abnormal shallowness and cut pay wash at right angles. The result is that bores give an exaggerated idea of depth and value.

To get the nearest approach to true values and depths close boring is necessary. When scout boring an area it is therefore better to space the lines far apart, but close bore in each line, placing the lines across the flow of the country. The values and depths at the respective lines will then be nearly correct and from this information it can be decided whether the area justifies close lining or not.

These widely spaced lines of close bores, while giving reliable information as to depths and values, are likely to be unreliable for the estimation of the extent or area of payable ground. As shown in Fig. 4, three lines, *a-a′*, *b-b′*, *c-c′*, have been placed across a property, but it is clear that owing to the fact that they cut across the run of alluvium obliquely, they give a completely wrong idea of the extent of the deposit. If all the bores in these three lines showed workable values, the impression gained would be that the whole area was workable. As, however, the payable alluvial deposit follows a tortuous course, only about half the area is workable. To get a true idea as to the extent of a deposit, close lining is necessary.

Having close bored a property and having obtained more or less correct values and depths at bore sites it is necessary to obtain from these results the average depth and value of the land between the bores. Some prospectors, when trying to get the average depth and value of a line of bores, simply add all together and divide by the number of bores to get average depth, and add all foot-pounds together and divide by the total feet to get the average value. This is quite wrong, as it is not the average of the several bore sites that is required, but the average of the spaces in between.

To take a simple example of three bores :

No. of Bore.	Depth Ft.	Ft. Pounds.
1	10	5
2	40	60
3	10	5

This represents a line across a valley, shallow and poor at the sides, rich and deep at the centre. If we add the footage together and divide by 3 we get the average depth of 20 ft., and if we add all foot-pounds together and divide by this total footage we get an average value of 1·17 lb. per cu. yd. Now it must be evident that the land between Nos. 1 and 2 and also between Nos. 2 and 3 must be 25 ft. (the mean of 40 and 10). The true average depth is therefore 25 ft. Likewise the average value of ground between Nos. 1 and 2 and also between Nos. 2 and 3 is 65 foot-pounds divided by 50, which equals 1·30 lb. per cu. yd., which is the true average value, not 1·17.

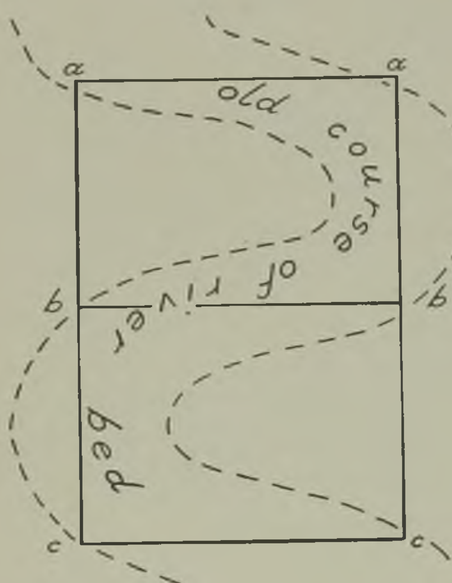


FIG. 4.

To get the true average of a line of bores, the outside bores should be taken once, and all inside bores twice. In the above example the result would be worked out as follows :—

No. of Bore.	Ft.	Ft.-lb.
1	10	5
2	40	60
2	40	60
3	10	5
	100	130

The average depth is 100 divided by 4 = 25, and the average value 130 divided by 100 = 1·30 lb. per cu. yd.

To obtain the average depth and value of land lying between two lines of bores, the results of the two lines are columned together, treating all outside bores once, and all inside bores twice.

	Bore No.	Ft.	Ft.-lb.
Line A	1	10	5
	2	30	30
	2	30	30
	3	25	25
	3	25	25
	4	10	5
Line B	1	8	4
	2	16	12
	2	16	12
	3	25	26
	3	25	26
	4	27	24
	4	27	24
	5	16	10
	5	16	10
	6	9	5

Adding the footage together and dividing by the number of bores we thus get 315 divided by 16 = 19·7, which is the average depth. The total foot-pounds 273 divided by this total footage 315 = 0·87, which is the average value in pounds per cu. yd.

Suppose Lines A and B were 10 chains apart and the bores were 3 chains apart in each line. Then the width of Line A is 9 chains, and the width of Line B is 15 chains, the average width being 12 chains. This multiplied by the distance apart, 10 chains, gives 12 acres. Twelve acres of average depth 19·7 ft. contains approximately 381,000 cu. yd., with an average value 0·87 lb. per cu. yd., so the gross content is approximately 331,470 lb.

Table I.—Page from Field Book.

Bore No. 21. Line J. Time commenced, 7.30 a.m. Position of Bore 6 chains East of J 20.

Date, 28.1.27 Time Finished, 11.10 a.m. Theoretical Content, 4·4 tenths of a ¼ cu. ft. for each foot in depth.

Superintended by A. S. S. Istant. Diameter cutting shoe, [illegible] in. Box used, ¼ cu. ft.

Sample No.	Depth of Section.	Total Depth.	Description of Ground.	Theor. Content.	Slime.	Solids.	Sand.	Corrected Slime.	Total Solids.	Total Sand.	Quantity of Material in Sample.	Value of Sample.	Full Can Value.	Ft. Pounds.
1	4	4	Grey Loam	18		8	2		8	2	8	nil	nil	nil
2	5	9	Yellow and white firm clay with red streaks.	31	8		4	10	25	10	25	trace	trace	trace
3	2	11	,, ,,			15	6							
4	3	14	Creamy sandy clay, very firm	13	5	7	2·3 2·7	6	13	5	13	,,	,,	,,
5	5	19	Creamy soft sandy clay, friable	22	8	12	3·7 4·4	10	22	8·1	22	·75	·34	1·70
6	5	24	,, ,,	22	8	12	3·3 4·4	9	21	7·7	21	1·30	·67	3·35
7	5	29	,, ,,	22	8	12	4·0 4·4	11	23	8·4	23	3·00	1·30	6·50
8	1	30	,, ,,	4·4	1½	2	·75 ·75	2	4	1·5	4	·48	1·20	1·20
9	5	35	Pebbly wash waterworn quartz pebble.	35		16	11		16	11	16	8·75	5·47	43·76
10	3	38	,, ,,											
11	2	40	Dec. schist bed rock.											38)56·51(1·49
12	5	45	,, ,,							53·7	132			
			Amang (heavy impurity)								132	18·50	1·40	

Notes. Friability $\frac{53\cdot7}{132}$ = 40% Sand.

Assay of Ore 69%. ∴ Ore $\frac{1\cdot49 \times 60}{72} = 1\cdot43$

Assay of Amang 1·2%. ∴ Amang $\frac{1\cdot40 \times 1\cdot2}{72} = \cdot02 = 1\cdot45$ Assay 72%.

Depth 38 ft.
Value 1·45 pounds per cu. yd. 72% Sn.

The Schedule of Bores, Table II herewith, shows the process of arriving at value of a property from the individual bore results.

TABLE II.

SCHEDULE OF BORES.

Lines 10 chains apart. Bores 6 chains apart in line.

Line No.	Bore No.	Depth in feet.	Foot lbs.	Doubling internal bores. No. of bores.	Doubling internal bores. Depth in feet.	Doubling internal bores. Foot lbs.	Total. No. of bores.	Total. Depth in feet.	Total. Foot lbs.	Calculations.	Acres.	Cubic Yards.	Total Pounds.
A	1	15	1·5										
	2	18	5·4	1	18	5·4							
	3	24	9·6	2	48	19·2							
	4	30	21·0	2	60	42·0	8	216	134·6	*A–B* $4 \times 6 = 24$ $4 \times 6 = 24$ $\frac{48}{2} = 24$ chains wide $10 \times 24 = 2 \cdot 4$ acres Depth $\frac{216 + 196}{8 + 8} = 25 \cdot 75$ ft. $= 8 \cdot 58$ yd. Value $\frac{134 \cdot 6 + 99 \cdot 2}{216 + 196} = \cdot 57$ lb			
	5	32	28·8	2	64	57·6					2·4	99,665	56,809
	6	26	10·4	1	26	10·4							
	7	20	4·0										
	8	15	1·5										
B	1	17	1·7										
	2	18	5·4	1	18	5·4							
	3	22	8·8	2	44	17·6							
	4	28	14·0	2	56	28·0	8	196	99·2	*B–C* $4 \times 6 = 24$ $5 \times 6 = 30$ $\frac{54}{2} = 27$ ch. wide $10 \times 27 = 2 \cdot 7$ acres Depth $\frac{196 + 207}{8 + 10} = 22 \cdot 4$ ft. $= 7 \cdot 47$ yd. Value $\frac{99 \cdot 2 + 129 \cdot 7}{196 + 207} = \cdot 57$ lb.			
	5	24	19·2	2	56	39·4					2·7	97,618	55,642
	6	22	8·8	1	22	8·8							
	7	16	1·6										
C	1	15	1·5										
	2	16	4·8	1	16	4·8							
	3	20	10·0	2	40	20·0							
	4	22	15·4	2	44	30·8							
	5	24	24·0	2	48	48·0	10	207	129·7	*C–D* $5 \times 6 = 30$ $5 \times 6 = 30$ $\frac{60}{2} = 30$ ch. wide $10 \times 30 = 3$ acres Depth $\frac{207 + 214}{10 + 10} = 21$ ft. $= 7$ yd. Value $\frac{129 \cdot 7 + 164 \cdot 6}{207 + 214} = 0 \cdot 7$ lb.			
	6	21	10·5	2	42	21·0							
	7	17	5·1	1	17	5·1					3·0	101,640	71,148
	8	15	1·5										
D	1	15	1·5										
	2	17	3·4										
	3	18	7·2	1	18	7·2							
	4	20	12·0	2	40	24·0							
	5	22	17·6	2	44	35·2	10	214	164·6				
	6	24	24·0	2	48	48·0					8·1	298,923	183,599
	7	22	18·6	2	44	37·2							
	8	20	13·0	1	20	13·0							
	9	18	3·6										
	10	16	1·6										

Total Area 8·1 acres containing 298,923 cubic yards.

Average Depth $\frac{298,923}{8 \cdot 1 \times 4,840} = 7 \cdot 6$ yards $= 22 \cdot 8$ ft.

Average Value $\frac{183,509}{298,923} = 0 \cdot 61$ lb. per cubic yard.

KURRA FALLS HYDRO-ELECTRIC STATION NORTHERN NIGERIA

By JOHN F. SHIPLEY, M.I.E.E.

In December, 1925, there appeared in the MAGAZINE an article describing the Kwall Falls hydro-electric power plant, which was installed on the property of the Northern Nigeria (Bauchi) Tin Mines and which has proved so successful. This plant continues to run satisfactorily and without interruption.

The scattered alluvial deposits of tin on the Nigerian Plateau, their relatively small size, and the high cost of providing power for small mines have resulted generally in heavy mining costs, and mining companies have always appreciated the possibility of reducing these by adopting the use of electric power.

Several companies have indeed investigated the possibility of developing power from some of the rivers flowing over the Plateau edge. One of the most promising hydro-electric projects examined was the harnessing of the falls on the Kurra River, lying about 48 miles S.S.W. of Jos. These falls, in common with other Plateau rivers, could be utilized to develop large powers during the seven months' wet season, but they become almost dry during the remainder of the year. A disadvantage was the fact that the Kurra Falls are on the outer fringe of the tin areas. Against these disadvantages, in the case of Kurra Falls, must be set the fact that water storage areas can be utilized, which would enable the plant to run continuously throughout the year by using the stored water during the dry months.

These falls had already been acquired and works commenced by the Nigerian Power and Tin Fields, Ltd., for the purpose of supplying power to the Nigerian Base Metals group of mines, and a considerable amount of work had been done in developing the site.

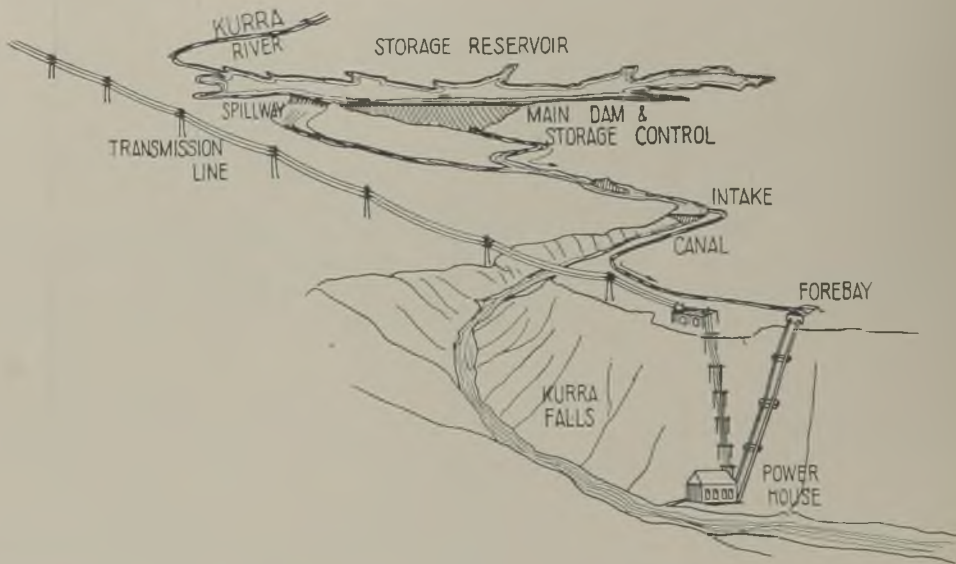


FIG. 1.—BIRD'S-EYE VIEW OF THE HYDRO-ELECTRIC INSTALLATION.

It had been realized for some time that co-ordination of effort and financial co-operation were essential for the prosperity of the tin mining industry of Nigeria, and an extensive amalgamation of interests has already been effected under the aegis of the Anglo-Oriental group, which is now interested in over 75% of the mines on the Plateau, including Associated Tin Mines of Nigeria, Ltd., Northern Nigeria (Bauchi) Tin Mines, Ltd., and Ropp Tin, Ltd. The group, therefore, in pursuance of its policy of development and consolidation in Nigeria, made, through its consulting engineers, a thorough investigation of the power possibilities of the Plateau. Several power projects were examined, and the one which offered the most immediate advantages—that at Kurra Falls—was adopted. A limited company, known as "The Nigerian Electricity Supply Corporation," was therefore formed in February, 1929, to acquire the site and complete the construction and equipment of the Kurra Falls installation. This corporation purchased from the Nigerian Power and Tin Fields, Ltd., the 45-year Government concession for utilizing the Falls, with the right of extension for 20 further years.

The programme of the corporation provided for the extension of the original scheme to generate up to 10,000 h.p. with 2,000 h.p. standby, so that during the wet season, when there is the maximum demand for power, 10,000 h.p. could be generated, while during the dry season 6,000 h.p. could be provided, for 16 hours per day.

Contracts have already been made for the output of this installation up to 6,000 h.p. for 15 years, and the company's revenue is thereby assured from the start. There are already signs that all the power available will be used.

The installation consists of a storage lake into which two rivers flow, while the outflow is controlled. From the storage lake the water flows by way of the old river bed to a small intake dam, from which, in turn, an open canal, 1,000 yards long, runs to a forebay. From the forebay two pipe-lines, each of 36 in. internal diameter and 2,000 ft. long, drop down to the power house, 750 ft. below. The pipe-lines feed three 2,000 h.p. Pelton wheels, and a 6,000 h.p. reaction turbine. The sketch diagram in Fig. 1 shows the general arrangement clearly.

Fig. 2.—Site of Power Plant, looking up the Penstock Line.

Fig. 2. shows the state of the work at the power-house and on the lower portion of the pipe-line, at the beginning of this year.

The electrical power will be generated at 6,600 volts, and will be conveyed by a short transmission line to a step-up transforming station on the Plateau edge. Here, the whole output will be transformed up to 33,000 volts, and thence transmitted along a 2-circuit transmission line as far as Bukuru, thus providing electric power through the most important tinfields. These main transmission lines will be tapped at important centres. Step-down substations will be utilized to convert the energy from 33,000 volts down to 3,300 volts for distribution to the mine areas. All motors of 50 h.p. and over will be connected direct to the 3,300 volt mains, while smaller motors will be connected to 400 volt circuits, which will be provided on the mines, the lighting being taken off one phase of these low tension power circuits at 230 volts.

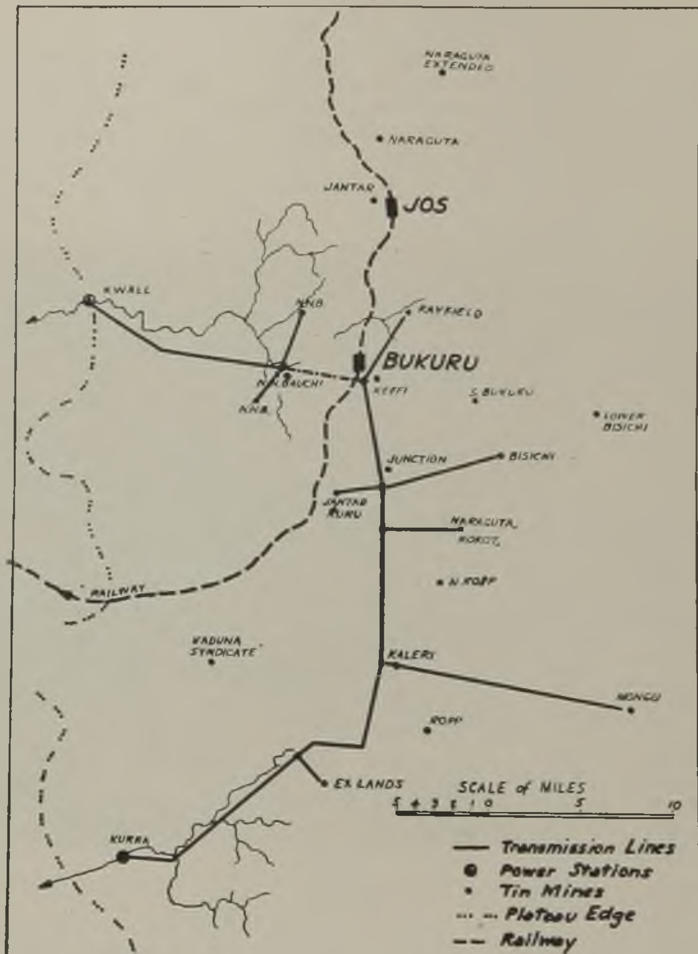


Fig. 3.—Distribution Diagram for the Hydro-electric Scheme.

Five substations are at present being provided for, and their position may be seen from the distribution diagram in Fig 3. This diagram shows the tinfields in general but it is still too early to fix the positions of all the substations. In a subsequent article, as the installation approaches completion, a more detailed description of the arrangements may be given.

It is expected that power will be available during 1930. Steps have been taken already to equip the mines for utilizing the electric power. The change over will proceed in accordance with the completion of the work on the power installation, so as to make the greatest possible use of the power available.

The experience already gained on the Plateau, and the great saving in working costs obtained by the use of electricity as a motive power are sufficient guarantees of the success of the new venture, which, under the policy of consolidation and supported by the technical and financial organization now concentrated in Nigeria by the Anglo-Oriental group, should reflect in increased profits of the producing companies on the Plateau.

BOOK REVIEWS

Winning and Working. By Prof. I. C. F. STATHAM. Cloth, demy octavo, xviii + 523 pages, illustrated. Price 21s. net. London: Sir Isaac Pitman and Son, Ltd.

This book has been written to meet the requirements of the syllabus for Winning and Working of the 2nd Class Certificate or Undermanagers Certificate Examination of the Board of Trade. The author has done justice to the task allotted to him. Most of the criticisms fall by the way when one bears in mind that the author has been so narrowly restricted. I fail, however, to understand why so much space was taken up with the description of the pulsometer and none at all was allowed for the description of an electrically driven sinking pump. In dealing with the setting out of gates and cross gates the author should have called attention to the disadvantages of forming acute angles.

I feel I must take issue with the Editor of this series of textbooks. Could anything be worse from an educational outlook than the production of a set of textbooks restricted in their outlook to a particular examination, and that of the standard of the 2nd Class Certificate. Such spoon feeding may be acceptable to the lazy candidate, but I cannot imagine a man with any vision keeping so closely within the limits of the knowledge demanded by the examination itself. It seems a pity that an author of Professor Statham's standing should have spent so much time in producing an admirable book for the purpose, when he is obviously capable of covering the subjects treated in the textbook in a manner that would have been acceptable to all.

K. NEVILLE MOSS.

Industrial Carbon. By C. A. MANTELL, Ph.D. Cloth, octavo, 410 pages. Price 21s. New York: D. Van Nostrand Company, Inc.; London: Chapman and Hall, Ltd.

This is the second volume of a series of Industrial Chemical Monographs and it may be said at once that it is an excellent production from all points of view. The author defines his object in producing the book as "an attempt to cover the technologic applications of elemental carbon aside from its use as fuel." The literature on carbon from this point of view is extremely scanty, in fact the main uses of carbon are of such recent date, and are so diversified that it is not easy to regard the subject as a whole. Few, if any, of the elements in their elemental form play such an extraordinarily diversified role, and none a more essential one, than does carbon. It is a far cry from printers' ink to gas masks, or from brilliants to motor tyres, while "lead" pencils and white sugar seem to have little in common, yet elemental carbon in one or other of its forms is essential to all of these and to dozens of other equally distant industrial products.

In this volume the author devotes a chapter or more to each of the main modifications of the element and its uses in industry, and he states that the magnitude of these uses can be gauged by that the fact that in the United States of America alone carbon and its related products to the value of over one hundred million dollars is produced annually.

The chapters dealing with carbon in the electrical industry are especially complete and interesting, for this industry has made such enormous strides in recent years that it has been difficult to keep pace with. Few will realize the enormous quantities of carbon now used for electrodes and similar purposes, while the high proportion of carbon as graphite used in the making of the treads of motor tyres will come as a surprise to most people who in other ways may have a fair knowledge of the subject.

Such of the divisions of the subject as the reviewer has personal knowledge of are admirably and adequately treated and the whole book can thoroughly be recommended not only for the information it contains, but as presenting that information in a most readable and interesting form.

TUDOR G. TREVOR.

Ball Clays: Special Reports on the Mineral Resources of Great Britain, Vol. xxxi. By DR. ALEX. SCOTT. Cloth, octavo, x + 73 pages, illustrated. Price 2s. 6d. London: H.M. Stationery Office.

The superiority of certain British table ware, particularly plates and saucers, is at once apparent to anyone who has used the thick platters of certain other countries. To this superiority of product we owe a healthy export trade, both of raw and finished material. The one factor more than any other to which this trade condition is due is the possession of our valuable ball-clay deposits. Information on our resources of these clays has heretofore been scattered in the memoirs of the Geological Survey and the transactions of various learned Societies, so that the present volume makes a timely appearance.

The author has divided his book into eight chapters and an appendix. Chapter I is introductory, dealing with the definition of, methods of using, and the uses of ball-clay. Chapters II–V deal with the three main deposits of North and South Devon, and of Dorset. Chapters VI and VII treat of the mineralogy, chemistry and physical properties of these clays. The last chapter is a short glossary of local and trade terms, and the appendix is a key to physical tests of certain type samples.

The chemical analyses now given are extremely valuable, and with the chapter on physical properties form the best features of the book, as few new mineralogical data are given. The publication of this information was needed, and the author is to be congratulated on the result.

Analytical Principles of the Production of Oil, Gas, and Water from Wells. By STANLEY C. HERROLD. Cloth, octavo, 650 pages, illustrated. Price 35s. San Francisco: Stanford University Press.

Mr. C. F. Tolman summarizes the purpose of this monumental work in well-chosen words which we cannot do better than quote here: "The problems of mutual interference of wells, spacing of wells, recovery of oil and gas, drainage of a pool by a well or a group of wells, and other important problems that have confronted the industry, the judiciary, and the government, can only be solved by the application of the theory expounded in this treatise."

It is a fact that nine-tenths of the average theory of petroleum occurrence and behaviour under artificial conditions of extraction constitutes an argument based either on environment (that is reservoir rock, etc.) or on specific performance in response to certain set circumstances of production. Discussions of petroleum as a fluid, as a form of matter obedient to fundamental laws which can only be expressed by a system of mechanics, are as rare as they are difficult, and have seldom penetrated far beyond the centres of learning in which they have from time to time been raised. Put this book into the hands of the purely practical production engineer, bred and brought up in the crude surroundings of the usual oilfield, and the result would be much the same as presenting a professional golfer with a thesis on the dynamics of a golf-ball. Give it to the man trained in oil technology, whose foundations of his subject have been well and truly laid in the lecture and class-room, subsequently matured by the stringent rules of real experience, and the possibilities are almost unlimited.

This is unquestionably a remarkable effort for one man and nothing quite like it has appeared before in the annals of petroleum literature. Bearing in mind that *all* fluid occurrences in the earth's crust are susceptible to the treatment accorded the subject here, it is clear that the author's work is of far-reaching consequence both in academic and commercial circles. As such, it is no easy task to convey to the reader a really adequate conception of this statement of first principles in the limited space at the disposal of a review, apart from the fact that no summary could be entirely sufficient for a work of this kind. In outline, the author takes as his standpoint the occurrence of fluids and first discusses them in relation to those laws of physics and properties of matter directly concerned, in particular with their production from crustal reservoirs. The control of fluid performance in these reservoirs is then vested in one or more of the three functions: hydraulic, volumetric, and capillary controls. Such reservoirs, and the controls implied in individual cases, are defined by certain mathematical features, as may be interpreted from production curves, etc.

In detailing this great system of analysis, the author selects artificial reservoirs to serve as types, and under each main control factor states the case for ideal performance, theoretic performance, and secondary functions of performance. In this way practically every possible occurrence of confined fluid, whether gas, oil, or water, is enunciated in relation to the inherent forces involved in determining behaviour under diverse conditions of production from wells. The author deals almost exclusively with theory, though this is based on extensive observations of actual conditions, on data which have been carefully collected, carefully sorted out, and still more carefully adapted to the explanation of the natural laws implied. It is left to Mr. E. K. Parks to translate the principles into values which the ordinary field-engineer may understand, in the form of a summary at the end of the volume.

The reader inclined to jib at a mathematical treatment of a subject he prefers to consider empirically or from a particular practical standpoint should pause before dismissing this work as being something too scholarly for his powers of comprehension. Scholarly it certainly is, but it is not a dull, unintelligible text. Every chapter commences with a relevant quotation from such diversified authorities as Voltaire, Poincaré, Newton, Galileo, Maxwell, and others, to select a few names at random ; it is as if the author had deliberately set out to humanize his subject, to claim the reader's attention at whatever point the book was opened. A perfectly lucid introduction prefaces each new hypothesis or each stage in the analysis which the author seeks to explain, and there are comparatively few sections where the mathematics involved are deep enough to worry a normally trained individual. At the same time, it is emphatically not the book to consult for an immediate reply to the question " how many wells per acre on this field ? " or " what is the significance of this or that pressure measured in well number so-and-so ? " A grasp of the essential principles of the author's teaching must be realized before the data can be turned to practical account, but that, after all, is the business of the modern engineer if he be a worthy member of his calling.

This work occupies over 650 pages, contains well over 200 figures in the text, is beautifully printed and bound, and is an achievement of which Stanford University, the author, and the petroleum industry in particular may justly be proud.

H. B. Milner.

NEWS LETTERS

JOHANNESBURG.

September 5.

Gold Still to be Won.—Dr. Hans Pirow, the Government Mining Engineer, has received many congratulations on the optimistic views he expressed regarding the future of the South African mining industry in his presidential address to the members of the Chemical, Metallurgical, and Mining Society of South Africa. Dr. Pirow firmly believes that another £1,000,000,000 worth of gold will be won from the Transvaal's present known gold deposits. It is estimated that the tonnage still to be crushed by the thirty-two large mines on the Rand is in the neighbourhood of 320,000,000, that in addition there are on the Rand several promising areas from which a further 180,000,000 tons of payable ore may possibly be drawn, and that the Pietersburg, Lydenburg, Barberton, and Klerksdorp districts will account for the balance of production to reach the total of a thousand million sterling. Sir Robert Kotze, late Government Mining Engineer, has pointed out that Dr. Pirow included in his estimate of the value of the gold remaining in the Rand mines the low-grade tonnage which is capable of being brought into the sphere of operation by a reduction in working costs. Various directions in which this can be achieved were mentioned during the session of Parliament just concluded, and merit the attention of the Government. If the mining of this low-grade ore is made possible it will be an enormous asset to the State. Another local authority, Dr. P. A. Wagner, has estimated that another £1,000,000,000 worth of gold will be won on the Witwatersrand alone. He probably believes that important new mines will be opened up on the Far West Rand where developments of a highly interesting nature are likely to take place before long.

It should be mentioned that Dr. Pirow also holds very optimistic views regarding South Africa's base mineral deposits. He thinks the future of South Africa as a mining community lies not in the maintenance of the present gold and diamond output, but " in the production of base minerals coupled with the manufacture of those finished articles which we are geographically suited to produce."

Dry Mining Theory.—Discussions have taken place on Dr. J. S. Haldane's proposals for avoiding silicosis by substituting dry mining methods for wet mining methods. Dr. Haldane holds that if the quartz dust could be mixed with shale dust the lungs would be enabled to work off the quartz dust which causes silicosis. He also stresses the fact that in deep mines water helps to raise the temperature, and when the temperature becomes too high miners become subject to heat strokes. Local opinion is that Dr. Haldane's scheme should be carefully investigated, but all experiments should be made under the strictest control. Mr. van Eyssen, consulting engineer to Messrs. Lewis and Marks, states that at the Lonely Mine, Rhodesia, many of the miners, both white and black, have worked there from the inception of the mine, yet not one of them is suffering from silicosis. This mine is a particularly dusty one.

Namaqualand Beryl Field.—Further interesting information concerning the recently discovered beryl deposits in Namaqualand have been furnished by Professor P. Kovaloff, consulting geologist. In a report to Beryllium (S.A.) Limited, Professor Kovaloff says there are numerous pegmatite veins in the company's property, and these are the carriers of a number of minerals, among which a prominent place is occupied by beryl. This mineral here occurs: (1) in scattered crystals, sometimes of exceptionally large size, reaching 2 ft. in diameter and 5 ft. in length; and (2) in crystal aggregates, forming pockets and nests in the pegmatites, each representing several tons of material. The largest nest found in the course of the short time of prospecting work on the property gave approximately 16 tons of beryl. The beryl from these occurrences is usually of a light green colour, but often blueish coloured beryl crystals are noticed. The mineral is not transparent, and crystals of beryl and aquamarine of gem quality have not yet been met with, although the possibility is that future development will disclose the presence of this quality of stones. Apart from beryl, the presence of tantalite, lepidolite, tourmaline, and other minerals is established in pegmatite veins developed on the area examined. Information has reached Professor Kovaloff that scheelite has been found in the locality covered by the company's prospecting areas. If this is confirmed, this mineral may represent a valuable by-product during the mining of beryl. Another by-product, also valuable, is tantalite, a nest of which (giving about 60 to 70 lb. of this mineral) was found in area No. 1. Finally, muscovite must not be lost sight of, as although it does not yield a sufficient quantity of large sheets to justify independent working, as a by-product, of a certain value, it can be turned to account as a probable source of additional revenue.

Measurements show that about 20 tons of beryl have been produced, and the total tonnage of rock mined in all the workings is about 400 tons, which corresponds to the percentage of beryl in pegmatite of more than 5%. As regards ore reserves, Professor Kovaloff states: "These results, together with the geological features as disclosed by surface examination, impress one with a general feeling that these reserves on the whole area of the company, will be rather of the order of hundreds of thousands of tons of beryl, than that of thousands only. In other words, the quantity of ore reserves on the company's holdings need arouse no anxiety." Analyses indicate that the BeO content of the ore is 10·35%, which corresponds to 3·6% of beryllium metal. Taking the average content of this metal at 3·5%, and allowing for 40% loss during extraction, Professor Kovaloff estimates the recoverable value of a ton of ore at £87, and the total cost of production, including transport to Europe, at £52 per ton of ore, leaving a net profit of £32 for every ton of ore produced in the event of extraction being undertaken on the spot as compared with £4 to £6 which would be the profit accruing if the ore were exported for extraction oversea.

Professor Kovaloff points out that the question of price plays a very important part in the increasing application of the metal beryllium. The present price exceeds £10,000 per ton, and even if production were to increase considerably from existing sources, it would remain in the neighbourhood of £5,000 to £6,000 per ton, which makes the use of it prohibitive for many purposes. The organization of marketing will undoubtedly lead to an almost unlimited increase of demand for this valuable metal. The reduction of the price of beryllium to the level of £4,000 per ton will still leave for the company a very large margin of profit, which level, there is every reason to believe, will be sufficient for a considerably wider application of the metal than at present.

Transvaal Emeralds.—In the Somerset mine, the first mine opened in the Murchison Range Beryl-Emerald Belt, a beryl crystal has been recovered which weighs 2,200 carats, or very nearly one pound avoirdupois, and measures 4½ in. by 2¼ in. The crystal has been insured for £10,000, but its actual market value will not be known until it has passed through the cutter's hands in London. Some of the emeralds produced from this mine have realized £100 per carat.

Rhodesian Coal Discoveries.—It is reported here that further important discoveries of coal have been made within the Northern Rhodesian copper region.

These new coal measures are said to outcrop below a considerable escarpment, and the coal is believed to be of fair quality.

Dredging for Tin.—News has been received from Swaziland that negotiations are proceeding which may result in an English company taking over one of the larger of the alluvial tin properties, originally held by Swazi Tins, Ltd., to work it as a dredge proposition, It is stated that numerous broad valleys and ample supplies offer facilities for this method of working alluvial deposits.

More Capital for Postmasburg.—A large parcel of the South African Manganese Company's reserve shares has been taken up at a premium of 100%, and the company now possesses sufficient capital to enable it to resume prospecting operations on its farms in the Postmasburg manganese fields. Overseas experts have made favourable reports on these farms, and it seems likely that eventually a new company will be formed to bring the properties to the production stage.

Prospecting in Bechuanaland.—On the recommendation of the High Commissioner, the Bechuanaland Advisory Council has decided to postpone action regarding the question of throwing open the Crown Lands in the Protectorate for prospecting purposes until the next session of the Council, which will be held early next year. It is rumoured that many influential natives are of opinion that the country's mineral deposits should not be exploited. In other words, they desire that Bechuanaland should remain a native reserve similar to Basutoland.

BRISBANE

August 19.

Mount Isa Activities.— Mr. Leslie Urquhart, chairman of the Mining Trust, Ltd., and of the Russo-Asiatic Consolidated, Ltd., passed through Brisbane lately on his way to Mount Isa. To the Press he gave an assurance that the work at the mines in the erection of the Mount Isa plant is up to the programme time, and said the mill and smelters should begin operations in the coming summer, with the initial output of 2,000 tons a day. Moreover, he sees no reason to amend the original estimate of profits, namely, that, with lead calculated at 20s. a ton and silver at 2s. an ounce, Mount Isa will give a return of 30s. per ton of ore treated. At present the market quotation for lead is over £23 a ton, and silver 2s. 0¼d. an ounce. As the first milling unit is to operate primarily on carbonate ores, the estimates for the moment are based on the production of lead alone, without taking into account zinc, which will also ultimately, when large tonnages of sulphide ore are available, be an important source of revenue.

As has already been stated, the ore reserves of the Mount Isa mines are estimated at 21,000,000 tons. Mr. Urquhart now says that this estimate has been proved by the exploratory and development work of the last eighteen months on the carbonate and sulphide ores in the Rio Grande, Black Rock, and Black Star lodes. The last-named is declared to be one of the greatest lead-zinc-silver mines of the world ; while it is confidently believed that further drilling and development in the near future will place the Mount Isa mines in a supreme position among those of the world producing these three metals. The work of the metallurgical test plant, too, it is asserted, has demonstrated beyond all doubt the reliability of the figures of metal recovery on which the original estimate was made. This estimate is that there will be a recovery of 91% of lead from the carbonate ores, and from the sulphide ores 87% of lead and 66% of zinc. No arrangements have yet been made regarding the treatment of zinc concentrates.

There are now 1,000 men employed at the Mount Isa mines, where construction work is proceeding apace and mining development is being pushed ahead vigorously. Mr. Chas. A. Mitke, one of Mr. Urquhart's technical staff, who is now on his way back from the field to Brisbane, says that owing to the last wet season not having filled the dam at Rifle Creek, water is the only trouble. The present domestic supply, which is good water, is taken from wells on the Leichhardt River, along which 15 artesian bores are being put down that will ensure a supply should another wet season fail. In the area inspected by Mr. Urquhart and Mr. D. P. Mitchell there is said to be a splendid running stream.

The Coal Industry.—The output of coal in Queensland during the first half of this year is a considerable increase on that of the like period of 1928, and the coal industry of almost the whole of the State is showing a decided improvement. While a good many of the additional orders being received are the result of the stoppage of work on the most important fields of New South Wales, a considerable proportion are to meet demands for overseas. Trade with the East is steadily growing. The principal shipments are from the Burrum field, near Maryborough, and about 200 miles north of Brisbane, and from the Bowen River field, inland from the port of Bowen, further north. The quality of the coal from both places is good, and loading at Bowen is now expeditious and otherwise satisfactory.

Hopes for an early settlement of the coal dispute in New South Wales, which has kept 12,000 miners out of employment for six months, were shattered a few days ago, when, at a conference of combined mining unions, called at the instance of miners, a proposal submitted by the engine drivers for the reopening of the mines was rejected by ten votes to nine. The great stumbling block has hitherto been the definite refusal of the miners to accept a reduction in wages, but the associated coal owners, who have closed their mines, are now insisting on other conditions before those mines are reopened. One of these conditions is that they shall have absolute discretion in the employment or dismissal of men. The Melbourne Gas Co. has received and has on order from England and New Zealand 19 shipments of coal, the total cost of which is about £360,000. The Victorian Railway Commissioner, who controls the Wonthaggi State coal mine, has caused a great stir by raising the price of the product of that mine by 10s. 6d. a ton, and also imposing restrictions on its sale to the public.

The New Mount Morgan Company.—The new Mount Morgan company, which is to be registered in Sydney, will have a nominal capital of £200,000, in shares of £1 each. It is intended to issue 115,000 shares, of which 25,000 will be fully-paid vendors' shares, allotted as part payment for the assets bought from the old company; while only 30,000 will be offered for public subscription. The vendors are also to receive in cash £70,000, which was the amount paid for the mine and properties. These assets, which were shown in the old company's books at £672,950, are now valued at £294,000.

The policy of the new company (Mount Morgan, Ltd.) will be to dispose of the plant not needed as soon as possible; to increase the capacity of the precipitating plant, which has continued in commission up to the present; and to determine the most suitable economic process for treating the accessible ore. This ore, which it is considered can be mined at 31s. a ton, will, it is estimated, give a return of 9s. a ton. Mr. Boyd, the late General Manager at Mount Morgan and a director of the new company, calculates that, with an expenditure of £10,000 on new plant, an annual profit will be realized of £27,518, based on £77 a ton as the price of electrolytic copper, which is at present quoted at over £84.

Oil Prospecting.—There are 19 companies, putting down 21 bore-holes, now prospecting for oil in Queensland. All of these, except three, are operating in the Roma district, from 300 to 350 miles west of Brisbane. In quite a number of the wells indications which are considered favourable for oil have been met. Principal interest still centres in the work of the Roma Oil Corporation at Roma. This company's No. 2 bore-hole struck what was considered bedrock at a depth of about 4,000 ft., without having come upon either oil or petroliferous gas in quantity, and was closed down. Renewed attention was then given to No. 1 bore, whence both petroliferous gas in large quantity and light oil had come in at about 3,700 ft. The cleaning out and further sinking of this bore resulted in a flow of gas amounting to 1,270,000 cu. ft. a day, when it was got under control. It is estimated that, uncontrolled, the flow would now be over 20,000,000 cu. ft. per day. The small absorption plant that had been installed was put to work, and has obtained oil at the rate of 2·4 pints per 1,000 cu. ft. of oil. Light oil has also been flowing from the well since July 31, and to date 16 gallons have come through. The sinking of a second bore, one of two started by the Australian Roma Oil, Ltd., has also been stopped at a depth of 3,132 ft., because of having reached bedrock in granite. This well is situated twelve miles north of Roma.

Solomon Islands Gold Find.—News of the first find of gold in the Solomon Islands has been brought to Australia by the discoverer (Mr. W. Newall). On a plantation on one of these islands (New Georgia) Mr. Newall had been living with his wife for ten years. The discovery was made through a native, who offered to sell to Mrs. Newall for 1s. a tin of coloured sand, which was found to be plentifully studded with gold. Twenty miles from his home, in rugged hills among dense overgrowth, Mr. Newall found two reefs with gold-bearing ore, as well as a certain amount of alluvial gold in a washaway. Samples of the ore, sent to Sydney for analysis, went 3 oz. 16 dwt. of gold and 1 oz. 6 dwt. of silver per ton. Several prospecting parties have left Tulgai to examine the field.

VANCOUVER

September 9.

ATLIN.—Between 400 and 500 claims have been staked along the Tulsequah River, a tributary of the Taku River, as the result of a discovery of gold-silver ore by Mr. Valentine, a prospector, and his disposal of a 55% interest in his claims to the Alaska-Juneau Mining Company, for $25,000 cash and similar amounts in six and in twelve months. If the vein persists the company has undertaken to develop and equip the property without cost to Mr. Valentine. Part of the vein cropped on the bank of a creek. On breaking off the oxidized capping, Mr. Valentine found it to be heavily mineralized, so he stripped the surface from the unexposed part and laid bare a vein 30 ft. wide. He then made a flume and brought water from higher up the creek to a point above where he had stripped the vein, washed away the loose earth and broken rock and exposed a 30 ft. vein for some way above the creek. News of the discovery brought scouting engineers for three large development companies who made offers for the property, that of the Alaska Juneau company being the one that Mr. Valentine finally accepted. Samples across the full 30 ft. are said to average about $20 in gold and silver per ton. The chief associated mineral is pyrite, but zinc-blende, galena, and chalcopyrite also occur.

The United Eastern Mining Co., of Los Angeles, has had a party since early in the season exploring a 25 ft. deposit of similar ore in the same neighbourhood. It has done a considerable amount of surface work, nearly 500 ft. of driving and some diamond-drilling, which Mr. J. B. Stapler, general manager for the company, describes as entirely satisfactory, but at the present time is not ready to give any detailed information. He was in Victoria to urge the Hon. W. A. McKenzie, Minister of Mines, to co-operate with the Alaskan Government in the construction of a road to the properties. He states that the navigation of the Taku is dangerous and costly, and that the freight on supplies he took to the property cost approximately five cents per pound. The Minister has instructed Dr. J. T. Mandy, resident mining engineer for the district, to proceed to the property and make an examination and report. This report will be awaited with interest.

SMELTING COMPANIES.—The Granby Consolidated Mining, Smelting, and Power Co. and the Consolidated Mining and Smelting Co. of Canada have adjusted their freight and smelting rate differences, and concentrate from Granby's Allenby mill is again going to Tadanac to be smelted. The company also has arranged to ship 1,000 tons of blister copper per month from Anyox to Tadanac to be refined, so the copper department at the smelter is again in full operation. It is just one year since Granby diverted the Allenby concentrate from Tadanac to Tacoma. The five-year period during which the Federal Government undertook to give a bounty on the production of copper rods and bars expires next year. This bounty started at 1½ cents per pound and gradually diminishes until it expires in 1930.

The Provincial Water Board has given the West Kootenay Power and Light Co. one year in which to prepare plans for the board's approval of a power plant on the Adams River, near Kamloops. The company, which is Consolidated's power subsidiary, will have the plans ready in three months, and if approved will start construction immediately after. It is estimated that 30,000 h.p. can be developed. The company intends to use this to supply the Boundary district and Granby's Copper Mountain mine and Allenby concentrator, thereby releasing power now used for these purposes for the Tadanac smelter. The company will erect a high-tension transmission line from the power station on Adams River to Vernon by way of Kamloops, and along the shore of Okanagan Lake to join the existing Bonnington Falls-Copper Mountain line at Kelowna. It is probable that the company will start this winter on the construction of an 80,000 h.p. plant on the Pend d'Oreille River, and it has made application to the Federal Government for the right to build a dam across the mouth of Kootenay Lake, to raise the low level of the lake 6 ft., thereby giving a more regular power capacity to its three Bonnington Falls stations. This request will have to be considered by the International Joint Commission, as it affects both Canadian and United States territory. Expansions contemplated and under construction at the Tadanac smelter will absorb some 150,000 h.p. ; the first two units of the fertilizer plant will absorb 74,000 h.p.

Consolidated has put a new electric steel furnace, capable of producing six-ton steel castings, into operation. The furnace will use scrap metal, of which there is an enormous accumulation at Tadanac, and may be made to produce either cast iron or steel castings, melting at the rate of three tons per hour. It absorbs from 3,000 to 5,000 h.p. of electric energy. Consolidated is reported to have staked a large number of claims along Peacock Creek, which lies midway between Houston, on the Canadian National Railway, and Owens Lake, where important discoveries of copper-silver-gold ore are said to have been made. The company has re-located several claims on Quartz Creek, a tributary of the Unuk River, in northwestern British Columbia.

The Kootenays.—Bluebell Mines, a new company that has been formed to take over and develop the Bluebell mine, at Riondel, on the east side of Kootenay Lake, is said to have made arrangement for funds to finance one-year's development. The considerable tonnage that the mine has produced has all come from the Bluebell claim. The new company will sink on the extension of the deposit on the Comfort claim, drive a series of levels toward the old workings, 1,500 ft. away, and develop a large tonnage before any attempt is made to produce ore. Mr. S. S. Fowler, who managed the mine for the old French Company, is president of the new company and Mr. B. L. Eastman is managing director. Messrs. Fowler and Eastman have had the mine under lease and option for several years.

Goldfield Consolidated Development Corporation has taken a lease and option on the Berengaria mine, at Deanshaven, to the south of the Bluebell, for $75,000, payable in three equal instalments at one, two, and three years. The company is to pay 15% of all smelter returns from ore shipped during the option, such payment to go toward payment for the property. The deposit was discovered about two years ago by Mr. R. T. Deane, in ground sluicing for an approach to a wharf that he intended to build. It was 10 to 12 ft. wide, but instead of being enclosed between rock walls, it was bounded on either side by boulder-clay, which gave rise to the natural theory that it was a huge boulder. Mr. Deane and associates formed the Berengaria Mining Co., which drove on the deposit and shipped 114 tons; this gave a smelter return of 3·6 oz. of silver per ton, 8·5% of lead, and 11% of zinc, and yielded a return of $4 per ton, after freight and treatment charges had been paid. The company then leased the property to three miners who shipped 240 tons of rather better grade, and exposed a face 20 ft. high in an open-cut. Writing of the deposit in the Annual Report of the Minister of Mines, Mr. A. G. Langley, former resident mining engineer for the district, says: "The impression was formed that it might be an enormous glacial erratic that had been protected from disintegration by the enveloping boulder-clay. It is considered possible, however, that the mass of ore, which lies in approximately correct relation to the adjacent stratified rocks, has slid down from its original position, which may not be very far distant. In this case a discovery of importance may be made in the vicinity." The Goldfield company, with its powerful financial resources, is better able to solve the problem than a small local concern.

Mr. M. Kinsella, chief owner of the North Star mine at Kimberley, has reopened the mine and is shipping ore to Tadanac. The mine produced a considerable tonnage of ore while under lease to Mr. O. C. Thompson and associates, but has been practically idle since he transferred his lease to Porcupine Goldfields Development and Finance Co. some five years ago. The Porcupine company did some diamond-drilling on the property, the result of which is not known.

Boundary.—Ventures, Ltd., has taken a short option on 400,000 in Aurum Mines at $1·25 per share. Aurum Mines has an authorized capitalization of $1,000,000 in $1 shares, only part of which have been issued. The company has been exploring a large consolidation of claims, including the Emancipation group, but, according to Mr. H. G. Nichols, resident engineer for the district, much of the effort has been misdirected. Some spectacular gold ore has been found in small veins and veinlets occurring in slate and greenstone in or near a serpentine formation. The gold is often associated with arseno-pyrite, which occurs in the veins in kidney-shaped swellings. The zone in which the ore occurs is some 60 ft. wide and has been subjected to heavy pressure that has contorted and crushed the formation. This zone has been penetrated by two tunnels, but two tunnels at lower horizons have failed to find the zone, and, according to Mr. Nichols, are not aimed in the right direction to do so; nor is it clear that the crushed zone will persist to their depth.

TORONTO

September 18.

MINERAL OUTPUT OF CANADA.—The expansion of the mining industry is reflected in the figures showing the mineral production for the first six months of 1929, which represented a total value of $123,702,334, as compared with $105,632,571 for the corresponding six months of 1928, an increase of 17·2%. The greatest gain was in the metallic output, with a valuation of $75,476,321, as compared with $62,967,411, being a gain of 19·9%. The most outstanding advances were in nickel and copper, the production of the former metal being nearly 55,000,000 pounds valued at $12,872,029, an increase of 18·3% in quantity and 21·1% in value over the corresponding total for the first half of 1928, while copper was produced to the amount of 115,586,068 pounds, valued at $21,124,581, as compared with 93,288,209 pounds valued at $12,569,660. Gold showed an increase of 3·7%, with an output of 940,005 oz. valued at $19,431,626. The outputs of coal, petroleum, and natural gas showed substantial gains.

COAL DISCOVERED IN ONTARIO.—In view of the efforts which have been made for some time to secure a supply of fuel for Ontario from domestic sources in place of having to depend on imports from the United States, the discovery of coal on a commercial scale in Northern Ontario is considered the most important recent mining development. Some time since, outcroppings of lignite were found at Blacksmith's Rapids, on the Abitibi River 90 miles north of Cochrane. A comprehensive campaign of diamond-drilling, undertaken by the Provincial Department of Mines, has disclosed a bed of lignite covering at least one square mile, of an average thickness of 18 ft. The tonnage so far indicated is officially estimated at 20,000,000 tons, and the exploration, which is still in progress, may show it to be considerably more extensive. Preparations are being made for the sinking of two shafts in order to procure bulk samples for further tests. The Temiskaming and Northern Ontario Railway, which is being extended northward to James Bay, is expected to reach the coalfield next spring. The surrounding area has been withdrawn from staking.

SUDBURY DISTRICT.—International Nickel is maintaining production at a high level, working at capacity in order to meet the increasing demand for the metal for which new uses have been found. The ore now being treated is from the lowest horizon of the Frood mine, of higher grade than any previously supplied to the mill. At the 3,000 ft. level there is a large width of ore carrying 20% copper in addition to the normal nickel content, which gives promise of a considerable increase in profit. Owing to this favourable outlook, it is considered likely that the company's plans for expansion will be revised with a view to greater smelter capacity than that originally provided for. Activities in the Sudbury area have been stimulated by the prospects of increased transport facilities. In addition to the line being built to the Falconbridge, where good progress is being made with the construction of the smelter, the Canadian Pacific Railway, will construct a branch from the main line near Chelmsford into the Treadwell Yukon property, six miles distant, which is expected to be completed by December. At the Errington mine of this company, mineralization shows a distinct improvement at a depth of 500 ft., at which level the two shafts are to be connected, following which a programme of deeper mining will be carried out, a shaft being put down to 1,500 ft. Diamond-drilling on the Sudbury Offset has indicated a large deposit of nickel ore.

PORCUPINE. — The production of Dome Mines, Ltd., for the month of August is valued at $317,727, compared with $320,626 for July, and $315,850 for August 1928. The output for the first eight months of 1929 is valued at $2,909,174, compared with $2,946,255 for the corresponding period of last year. Preliminary estimates give the output of Hollinger Consolidated for the first eight months of the year at an average of about $700,000 a month, the mill operating at an average rate of about 4,000 tons per day, with ore carrying a little less than six dollars per ton, and an average recovery of $5·65. This grade is considerably lower than that estimated at the beginning of the year, in view of which the management is devoting much attention to the reduction of costs. Exploration will also be carried to a depth greater than so far reached in this district, as the porphyry formation of the McIntyre is believed to dip in to the Schumacher section of the property considerably below the present workings.

The McIntyre-Porcupine has established a new high record of production for the first eight months of the year, the mill treating about 363,000 tons of ore with an output valued at approximately $2,800,000. Current profits are a little under 50% of gross output. The West Dome is making good progress with development. Stoping is proceeding on two levels, the 1,200 and 1,050 ft. horizons, with good results being obtained. The Vipond, during the financial year terminating July 31, produced about $800,000. The mill is handling about 9,000 tons of ore per month, which carries about $7 to the ton. While the company is in a position to pay dividends, the management prefers to pursue a course of policy until the continuity of ore deposits at depth has been definitely proved. Negotiations are on foot for the purchase of the Ankerite mine by Ventures, Ltd. The Ankerite has been under development for about five years, but the results have been disappointing, and the funds of the company are about exhausted.

Kirkland Lake.—The annual statement of the Lake Shore for the financial year ending June 30 shows production valued at $5,504,858 from the treatment of 367,015 tons of ore, with an average recovery of $15 per ton. This shows an increase of 51% over the output of the previous year. The net profit after all deductions was $2,882,115. Good progress is being made with the installation of machinery which will largely increase the milling capacity. The question of mill enlargement is engaging the attention of the management of the Teck-Hughes, but it has been decided to await the results of exploration at the lower levels and ascertain the size and character of the ore-bodies before coming to a final decision. The Wright-Hargreaves during the first eight months of the year, according to preliminary estimates, produced gold to the value of approximately $1,050,000 from about 123,000 tons, with a recovery of about $8·50 per ton. During the earlier part of the year a large tonnage was milled, but production was subsequently curtailed. Current operations are at the rate of about 13,000 tons per month, with an output of approximately $100,000. Underground work at the 2,100 ft. and 2,200 ft. levels promises good results. The Ritchie has cut a well mineralized vein 7 ft. wide showing fair gold values on the 500 ft. level. The Amity Copper and Gold Mines, which has been taking good ore from the 600 ft. level, has begun lateral work on the 1,000 ft. level, and should development at depth realize expectations, a concentrator will be erected. The Mindoka, in the Boston Creek area, is putting down a shaft in which good ore is showing at intervals, and has shipped a carload to the Noranda smelter.

Rouyn.—Diamond-drilling at the Amulet has disclosed a large addition to its ore reserves. This has decided the company to proceed with the construction of a concentrator, the machinery for which has been placed on order. The Granada-Rouyn has cut an important vein 12 ft. in width, stated to carry $30 in gold to the ton over a width of 2 ft. Driving is being proceeded with, showing that the width is well maintained. Diamond-drilling at the Siscoe having yielded highly encouraging results, the directors have adopted a programme of expansion and ordered additional mining machinery for carrying the workings to greater depth. A three-compartment shaft will be put down to the 550 ft. level. Among other properties where active operations are in progress are the Abana, Windsor, and Newbec.

Manitoba.—The Hudson Bay Mining and Smelting Company, operating the Flin Flon mine, and the Sherrit-Gordon Company have awarded contracts for construction, and work is being energetically carried on. The Flin Flon smelter will be very substantially built, of fire-proof construction, and of the most modern design. The early completion of the branch railway to the Sherrit-Gordon property will enable the machinery for the plant to be brought in before the winter. They have contracted with Hudson Bay Mining and Smelting Company for the supply of 5,000 h.p. of electricity, and also for the smelting of their copper concentrates. It is officially estimated that the Flin Flon smelter will be in operation by 1931, with an annual production of 30,000 tons of blister copper. An agreement has been entered into under which the blister copper output will be refined at the electrolytic plant to be erected by the Noranda interests in Eastern Canada. The Mandy will undertake explorations at depth by diamond-drilling from the 1,000 ft. level. The Manitoba Tin Company is meeting with success in its exploration work on the original tin discovery at Shatford Lake. A shaft has been put down 100 ft., and cross-cutting has encountered the mineralized zone, showing tin ore of good grade. There has been much activity in prospecting in the Cold Lake area. Ventures, Ltd., has taken an option on the Tab group of claims, 20 miles north of Cold Lake, and an extensive trenching and development programme has been commenced.

CAMBORNE

October 5.

PROSPECTING CONDITIONS.—Since all mineral deposits of economic worth become exhausted sooner or later, as a natural consequence of exploitation, the future of the mining industry, in Cornwall as elsewhere, depends upon the persistence of the prospector and the measure of success he obtains as the reward of his investigations. The sale of certain large Cornish estates in recent years resulted in the dispersal of some portions of the mineral rights in smaller parcels to various individual purchasers, or in the acquisition of large blocks of mineral rights by syndicates or companies. This has naturally been productive of changes in the methods of granting "tack-notes," licences and leases. On the whole the change of conditions has been harmful to the industry. In some instances the mineral agent of the estate—the "toller" of former times—has disappeared, either because rights have been disposed of, or, if retained, they have been transferred to the charge of the legal representative of the lord. As a consequence, whereas in former days lords and their mineral agents were invariably ready to grant facilities to prospectors, it has of late become the vogue to place obstacles in their way. Moreover, where applicants succeed in obtaining grants it is too often the case that procedure, instead of being prompt, is aggravatingly slow, while preliminary costs, instead of being nominal, are prohibitive.

Notwithstanding these changing conditions it is worthy of note that prospecting of late, and at present, in Cornwall is characterized by vigorous persistence. Examples exist in Wheal Buller and Lambriggan, both of which were successfully unwatered last year and have since been the scenes of systematic exploration and development.

WHEAL BULLER.—This mine, with the adjoining sett of Wheal Beauchamp, was one of Cornwall's famous copper producers, especially during the early half of the last century, the sales of copper ores having realized about three-quarters of a million sterling. Worked on the old cost-book system, in a small number of shares (usually 64, or multiples of that number—in the case of Wheal Buller 256 shares) business was done in these shares at £1,000 each, because of the divisible profit then being made. From the deeper levels, and during the later working, black tin was sold to the value of about £100,000, although the greatest depth attained was barely 1,000 feet from surface. For more than half a century no work had been done on Wheal Buller till the National Mining Corporation recently made provision for draining the mine. Subsequent investigations proved to be favourable, and operations are now in hand to develop the property below the comparatively shallow depths reached by former workers. To that end sinking has been steadily proceeding of late, and the mine has been suitably equipped with pumping, hoisting and other plant necessary for carrying out an extensive scheme of development.

LAMBRIGGAN.—At the time when the Chivertons were at their best, this property attracted the favourable notice of the then manager of West Chiverton. A vertical shaft of small dimensions was sunk to a depth of nearly 300 feet from surface. Crosscuts were driven to the main lode at 120 feet and 240 feet, and from these depths over 800 tons of galena and an unrecorded tonnage of zinc blende were sold. Deeper sinking was not possible with the pump of limited capacity then existing, and, although the property continued to be favourably regarded in the district, nothing was done at the mine till about two years ago. Since then the shaft has been cleared, enlarged to 14 feet by 6 ft. 6 in. within timber, deepened to 410 feet, and the former workings have been rendered accessible and thoroughly examined. Sinking is being continued, and it is intended to crosscut to the lode at a depth of about 420 feet.

Meanwhile development has been steadily carried on at the shallower levels, in each of which payable ore has been laid open both to the east and the west of the crosscuts. At the deeper of the two levels a length of about 250 feet of payable ore has been exposed, the width of the lode varying between 4 and 8 feet.

FORESHORES AND RIVER-BEDS.—Prospecting of quite a different character is being carried out on an ambitious scale on the foreshores and river-beds. These have for a long period, especially at times when the price of tin ruled high, proved attractive to prospectors, who occasionally met with considerable success, although no attempt was ever made to handle large quantities.

In olden time the valleys of Cornwall and of Devon yielded stream tin in abundance, and through a period embracing many centuries. Later some of these same valleys proved to be convenient "resting places" for the wastes from the mines. Consequently in the Carnon Valley, the St. Erth and other valleys, the original alluvial deposit, wholly or partially wrought centuries ago for stream tin, is covered by later accumulations of mine waste sands and slimes. Such wastes carried away, and still carry away, 30 to 40% of the chemically-ascertained tin contents of the original ores, so that they naturally offered, and still offer, inducements to prospectors.

The present attempts to render these valley deposits and the foreshores payable propositions have a much larger scale of operations in contemplation than any previously made. Naturally their progress is regarded with more than ordinary interest. The operations now in hand include: (1) Those relating to the Gwithian and Hayle foreshores and the sands accumulated underneath the sea in St. Ives Bay, tin-bearing sands carried down by the Red River with the effluent waters from the many mines that were situated adjacent to the river; and (2) operations in the Lelant and St. Erth valleys, where not only existing accumulations of mine tailings are being treated, but a payable bed of tin-bearing alluvial, overlooked by ancient "streamers," has been recently discovered.

In addition to the foregoing, operations on a smaller scale are being carried on in other river and stream-beds. Applications have recently been made in the proper quarters for permission to bore the foreshores and beds of both the Tamar and the Tavy rivers; also for permission to dredge Falmouth Harbour for tin between Trefusis and Mylor Creek.

Prospecting work above drainage level for lodes, or shallow workings upon lodes, continues, but the serious decline in the price of tin has, with some reason, discouraged this work. At Wheal Hermon, although a good deal was done in the shaft above adit level and at the adit, work is temporarily suspended. Work is reduced but not entirely suspended in some instances, for example, at Hingston Downs in the eastern part of the county, and at Mount Wellington, in the Carnon Valley, where exceptionally good results, on extensive sampling, have been obtained.

BEACH TIN.—It is of interest to record that the technical management of this company, which is working on the Gwithian Sands, has passed into the hands of Messrs. Bewick, Moreing and Co.

PERSONAL

R. A. ARCHBOLD has returned from Ecuador.

J. COGGIN BROWN is returning to Burma.

J. E. CLENNELL has returned to London and his address is c/o The Metallurgical Department, Chelsea Polytechnic, S.W. 3.

F. H. COTHAY has returned to Nigeria.

H. O. CRIGHTON is home from Ecuador.

E. H. DAVISON is home from Nova Scotia.

I. J. A. DIAMOND, of Johannesburg, has left for the Northern Transvaal and Swaziland.

A. H. FLOWERDEW has returned to Malaya.

G. A. HARRISON has been appointed general manager of the New Guinea Goldfields, Ltd.

J. N. HERRING is now in Mayo district, Yukon.

SIR THOMAS HOLLAND is home from South Africa.

PRESTON K. HORNER has returned from Rhodesia.

F. E. KEEP has joined the Staff of the City Deep Mine.

SIR ROBERT N. KOTZE is here from South Africa.

H. W. LAWS has returned from South America and British Columbia.

R. J. LEMMON is shortly returning from Russia.

ROSS MACARTNEY has left for Burma.

H. D. A. MAIDMENT has returned to Spain.

A. G. MCGREGOR has returned from New York.

L. A. MILLETT is home on holiday.

G. R. NICOLAUS has returned from West Africa.

CYRIL E. PARSONS is here from Venezuela.

THOMAS PRYOR has returned from West Africa and left for Canada.

A. L. J. QUENEAU is here from New York.

R. S. H. RICHARDS is home on leave from Portugal.

ALEX. RICHARDSON has returned from Canada and the United States.

W. H. RUNDALL, of Messrs. Pellew-Harvey and Co., has gone to the United States on a short visit.

DR. F. E. SMITH, F.R.S., Director of Scientific Research at the Admiralty, has been appointed to be Secretary to the Committee of the Privy Council for Scientific and Industrial Research, on the resignation of Mr. H. T. Tizard, F.R.S.

DAVID M. THOMSON is here from Ontario.

W. E. THORNE has left for Colombia.

H. A. TITCOMB has left for Central Europe.

A. T. WATSON has returned to Colombia.

R. B. WOAKES has returned to India.

J. NORMAN WYNNE is home from Tanganyika.

H. H. YUILL has been on a visit to London and has returned to Canada.

ALFRED H. COWLES, the inventor of the electric furnace for reducing aluminium, died at his home in New Jersey on August 13, aged 71.

GEORGE P. MERRILL, the eminent American mineralogist, died on August 15 at the age of 75. He was known in this country as an authority on non-metallic minerals.

RICHARD ZSIGMONDY, professor of Inorganic Chemistry at Gottingen University, died at Gottingen aged 64. Professor Zsigmondy was eminent in colloid chemistry and his invention of the ultra-microscope was of great importance. He was awarded the Nobel Chemistry Prize in 1925.

DAVID DRAPER, the doyen of the authorities on South African diamonds, died last month in his 79th year. He was one of the earliest prospectors when alluvial diamonds were discovered in 1867, and he continued to study the diamond all his life. Some years ago he contributed useful articles in the columns of the MAGAZINE.

TRADE PARAGRAPHS

The Dorr Co., Ltd., Abford House, Wilton Road (Victoria), London, S.W. 1, inform us that they have appointed Mr. H. R. Stoney chief engineer, in place of Mr. R. O. Stokes, who has resigned.

Westinghouse Electric International Co., of 2-4, Norfolk Street, London, W.C. 2, have issued leaflets descriptive of pipe fittings, engine driven d.c. generators, auto-starters, and a totally enclosed, fan-cooled, d.c. motor.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, send us the August issue of their *Gazette*, which contains an article describing the Perak River Hydro-electric Scheme, for the contracts of the whole of the switchgear for which the firm were responsible.

Consolidated Pneumatic Tool Co., Ltd., of 170, Piccadilly, London, W. 1, have published a collection of photographs which serve to illustrate the employment of their pneumatic tools of all kinds in different classes of work in all parts of the world.

The Mond Nickel Co., Ltd. (The Bureau of Information on Nickel), of Imperial Chemical House, London, S.W. 1, issue a new bulletin on the subject of nickel steel, giving particulars of the employment of these steel in high performance internal combustion engines.

Bell's Asbestos and Engineering Supplies, Ltd., of Asbestos House, Southwark Street, London, S.E. 1, inform us that they have transferred their head office from London to their new works at Slough. They have at the same time established London offices at 157, Queen Victoria Street, E.C. 4, and 239, Upper Thames Street, E.C. 4.

Hadfields, Ltd., of Sheffield, send us recent catalogues devoted respectively to Era C.R. corrosion resisting steel and Era H.R. heat resisting steel, the respective qualities of which have been pointed out in these columns from time to time in the past. They also send us copy of their catalogue devoted to stainless steel and iron.

British Industries Fair, 1930. The organizers of the Birmingham (or heavy) section of the above in issuing a progress report draw attention to the new departure in the forthcoming Fair by which an advance catalogue giving particulars of the principal new or improved products to be displayed, some 10,000 free copies of which will be issued early in December.

The Geophysical Co., Ltd., of 62, London Wall, London, E.C. 2, have come to an arrangement whereby they will work in co-operation with the **Electrical Prospecting Co.,** of Stockholm, and also with **Seismos,** of Hanover. Professor Dr. L. Mintrop of the latter Company has joined the Board of the Geophysical Co., of which he will be Vice-Chairman.

British Engine Boiler and Electrical Insurance Co., Ltd., of 24, Fennel Street, Manchester, issue their Technical Report for 1928, which as usual contains an interesting record of boiler and other accidents concerning the causes of which extensive enquiries have been made. The Report is fully illustrated with micro and other sections and photographs of cracks or other injuries to structure.

The General Engineering Co., of Salt Lake City, Utah, with a London Office at Adelaide House, E.C. 3, of which Mr. R. O. Stokes has been appointed manager, issue their Metallurgical Bulletin comprisiug 127 pages fully illustrated with photographs, flow sheets, and graphs, together with much tabular matter. The booklet serves to describe the various directions in which this company can assist the mining engineer in the matter of the design of mills for the treatment of metalliferous mine products. The booklet also contains a wealth of interesting statistical information.

Andrews Toledo, Ltd., of Toledo Steel Works, Sheffield, send us a catalogue of their steels including tool steels, motor-car and aircraft steels and special steels. Under the heading of tool steels is a section devoted to mining drill steels. These include "B.C. Special," "Safety," which is a vanadium steel, "Sturdy No. 1," and "Sturdy No. 2," suitable for tunnelling and quarrying work. These steels are made solid and hollow and in various cross sections. The catalogue is completed by the addition of a heat treatment chart, giving instructions for the forging, annealing, hardening and tempering of the various classes of steel.

Ruston and Hornsby, Ltd., of Lincoln, inform us of the formation of a new subsidiary company with the **Bucyrus-Erie Co.,** of South Milwaukee, to be known as **Ruston-Bucyrus, Ltd.,** with works and head office at Lincoln. The Spike Island works of Ruston and Hornsby, Ltd., which has heretofore been exclusively devoted to the excavating side of their business, will in future be given over to similar work of and by the subsidiary. Thus Ruston and Hornsby, Ltd., will contribute the excavator side of their business and Bucyrus-Erie Co., Ltd., will contribute the equivalent value in cash and will transfer to the new Company the whole of their interests in countries outside North and South America, Japan, and China. The new Company will commence operations on January 1st, 1930. The following will comprise the Board: Mr. William W. Coleman (Chairman), Col. J. S. Ruston (Vice-Chairman), Sir Archibald Ross, Col. P. D. Ionides, and Messrs. G. R. Sharpley, J. H. W. Pawlyn, R. W. Newberry and V. W. Bone. The last named will be Managing Director.

International Combustion, Ltd., Grinding and Pulverizing Offices, of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment:—For England: Two 7 ft. by 36 in. Hardinge ball mills and two 6 ft. Hardinge air classifiers for slate; one 3-roller Raymond mill for amorphous graphite; one No. 00 Raymond pulverizer for milk sugar; four 4 ft. by 5 ft., type 39, Hum-mer screens for nitro chalk; two 4 ft. by 5 ft., type 37, Hum-mer screens for cement slurry; one 4 ft. by 7 ft., type 39, Hum-mer screen for coal; two 4 ft. by 7 ft., type 60, Hum-mer screens and one 4 ft. by 7 ft., type 39, Hum-mer screen for coke; one 3 ft. by 8 ft. Hardinge ball mill for iron sesqui oxide; and one Rovac filter unit for cobalt hydrate. For Yugo-Slavia: Two 8 ft. by 48 in. Hardinge ball mills for lead-zinc ore. For Australia: Four 8 ft. by 36 in. Hardinge ball mills for gold ore. For Africa: One 3 ft. by 8 in. Hardinge ball mill for copper ore. For Spain: One 4½ ft. by 16 in. Hardinge pebble mill for slaked lime; and one 4 ft. by 5 ft., type 39, Hum-mer screen for foundry sand. For Nigeria: One 3 ft. by 8 in. Hardinge ball mill for tin ore. For Norway: One 6 ft. by 60 in. Hardinge ball mill for anthracite. The International Combustion Co. also inform us that they have taken over the British Rotary Filter Co., Ltd., the makers of the Rovac filter referred to in these columns in our issue of October, 1927. By this arrangement the firm secure the world rights in this equipment and are establishing a test laboratory at their Derby works for the carrying out of experiments side by side with those in crushing and screening. In a subsequent issue we hope to publish a description of this filter.

TEST LABORATORIES OF INTERNATIONAL COMBUSTION, LTD.

In these columns in our issue of January last some reference was made to the Derby works of International Combustion, Ltd., and in particular to the test plant there established for experiments in a variety of crushing and screening problems. We publish herewith a photograph of this plant, concerning which the following additional information may be of interest to readers of the MAGAZINE.

The purpose of this Laboratory is two-fold. It enables the firm to carry out tests to satisfy themselves as to the duty, capacities, and suitability of the various crushing and screening units for the manufacture of which they are responsible, and on the other hand it enables them to satisfy customers as to the utility of these machines for the particular problem submitted. The following comprises the principal equipment: A Raymond Lopulco 3-roller mill with air separator. This mill is similar to the German Loesche mill. A

3-roller high-side Raymond mill with air separator; a Hardinge 3 ft. diameter ball-mill with rotary and superfine classification systems. This same plant may be converted to another type of rotary separator or to open circuit grinding. A 3 ft. Hardinge ball-mill for unit coal firing and means for burning the pulverized fuel; a Hum-mer screen; a Raymond air separating plant; a Raymond Impact pulverizer for air separation; and a Raymond Impax pulverizer, which is a Beater type of mill.

SHIPPING, ENGINEERING AND MACHINERY EXHIBITION

This exhibition was held as on previous occasions at Olympia, London, W., from September 12 to 28 and among a variety of exhibits the following may be mentioned as being of more particular interest to mining men:

Stothert and Pitt, Ltd., of Bath, were showing examples of their rotary displacement pumps.

A. G. Mumford, Ltd., of Colchester, were showing electrically driven duplex pumps and other types.

Bernard Holland and Co., Ltd., of 17, Victoria Street, London, S.W. 1, were showing their special type of rotary air compressor and rotary vacuum pump.

Glenfield and Kennedy, Ltd., of Kilmarnock, Scotland, were showing an electrically operated sluice valve and other types of valves and water meters.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, were showing a number of marine type electric motors and other equipment for shipping.

Laurence Scott and Electromotors, Ltd., of Norwich, were showing electric motors, together with electrically operated winches and other ships' equipment.

Bull Motors, Ltd., of Quadling Street, Ipswich, were making a speciality of electric arc welding equipment, and were also showing electric motors and generators.

Ruston and Hornsby, Ltd., of Lincoln, staged a single exhibit of a 200 kilowatt marine auxiliary generating set comprising a 5-cylinder vertical airless injection Ruston oil engine.

Babcock and Wilcox, Ltd., of Babcock House, Farringdon Street, London, E.C. 4, were showing sections of water-tube steam boilers and oil-firing equipment together with a number of accessories.

Reavell and Co., Ltd., of Ranelagh Works, Ipswich, were showing a vertical two-stage compressor, a quadruplex compressor, a water-cooled rotary compressor and a number of rotary air motors.

Allen-Liversidge, Ltd., of Victoria Station House, Westminster, London, S.W. 1, were showing oxy-acetylene welding equipment, electric welding equipment and acetylene lighting sets of various types.

The Premier Electric Welding Co., Ltd., of Abbey Wood, London, S.E. 2, a subsidiary company of Imperial Chemical Industries, Ltd., were showing welding tools and electrodes and resistance welding machines.

Broom and Wade, Ltd., of Bellfield Works, High Wycombe, were showing a number of stationary and portable air compressors and pneumatic tools, together with lengths of wire-armoured hosepipe and sundry connections.

Edward Bennis and Co., Ltd., of Little Hulton, Bolton, showed a working exhibit of their forced-draught carrier-bar type chain-grate stoker with multiple air control also an automatic sprinkler stoker and a coking stoker.

Transporting Machinery and Engineering Co., Ltd., of 76, Victoria Street, London, S.W. 1, were demonstrating by means of working models the Bleichert bicable aerial ropeway, a drag-line scraper, and a cablecrane.

The Beldam Packing and Rubber Co., Ltd., of 16, Gracechurch Street, London, E.C. 3, displayed a range of their special packings and jointings which also include all types of asbestos, rubber, and other sundries for engineers' use.

The Consolidated Pneumatic Tool Co., Ltd., of Egyptian House, 170, Piccadilly, London, W. 1, exhibited a wide range of pneumatic tools, together with stationary and portable air compressors, Duff lifting jacks and electric tools.

The Sunderland Forge and Engineering Co., Ltd., of Pallion, Sunderland, were showing their vibratory screen, concerning which some more details will be published later. They were also exhibiting rock and coal drilling equipment.

Thorne and Hoddle, Ltd., of 151, Victoria Street, London, S.W. 1, were showing a comprehensive exhibit of acetylene welding and cutting plant with a variety of acetylene portable lamps and flares suitable for illuminating underground operations.

J. and F. Howard, Ltd., of Britannia Ironworks, Bedford, were showing a 2-ton 20 b.h.p. petrol locomotive, for a 24 in. rail guage. The engine is a Morris 4 cylinder. They were also showing a 3-ton 25 b.h.p. petrol locomotive with a Dorman 4 cylinder engine.

The Cambridge Instrument Co., Ltd., of 45, Grosvenor Place, London, S.W. 1, had a representative collection of instruments including CO_2 and CO indicators and recorders, draught and pressure guages, and a variety of temperature measuring apparatus.

Rapid Magnetting Machine Co., Ltd., of Magnet Works, Lombard Street, Birmingham, were showing drum type separators, a high intensity chute separator and a combined high intensity drum and chute separator, together with a variety of other electro-magnetic specialities.

Blackstone and Co., Ltd., of Stamford, were showing a 55 b.h.p. horizontal single-cylinder heavy-oil engine, and a 64 b.h.p. horizontal 2-cylinder oil engine direct coupled to a 230 volt generator. They were also showing unchokeable pumping sets for liquids carrying solids in suspension.

J. and H. McLaren, Ltd., of Midland Engine Works, Leeds, provided a range of McLaren-Benz airless-injection four-stroke high-speed Diesel oil engines. These engines have become familiar with mining people more particularly in their use as power plant for mechanical excavators.

Victory Valves, Ltd., of Adswood, Stockport, were showing a range of their products manufactured with wrought steel bodies in all types and in sizes from ½ in. to 24 in. bore. These valves are generally suitable for the highest working temperatures and pressures and some are electrically operated.

Norris, Henty and Gardners, Ltd., of Barton Hall Engine Works, Patricroft, Lancs., were showing a four-cylinder cold-start heavy-oil engine, developing 200 b.h.p. at 290 r.p.m. and also a 96 b.h.p. four-cylinder direct reversing engine of cold start type, and a number of other smaller engines.

Davey, Paxman and Co., Ltd., of Standard Ironworks, Colchester, were showing one of their 4-cylinder vertical cold-starting oil engines capable of developing 250 b.h.p. continuously with overloads up to an hour's duration up to 290 r.p.m. The injection of the fuel is on the Blackstone system.

Metallisation (Sales), Ltd., of 89, Upper Thames Street, London, E.C. 4, exhibited the latest improved metal spraying pistol by means of which metals or alloys that can be drawn into wire may be sprayed instantaneously on to metallic or non-metallic surfaces by the use of compressed air or other carrier.

The Stream-Line Filter Co., Ltd., of 45, Horseferry Road, Westminster, London, S.W. 1, were showing a range of stream-line oil renovators for reconditioning used lubricating and other oils, together with sectional models and table demonstrations of laboratory units to illustrate the principle of operation.

The Lea Recorder Co., Ltd., of 28, Deansgate, Manchester, were showing various types of apparatus for the measurement of solids and liquids, notably water recorders for gauging the flow of streams, etc., cubimeters for measuring the flow of granular materials in bulk, and flow meters for measuring pipe-line flows.

The North British Rubber Co., Ltd., of 200–208, Tottenham Court Road, London, W. 1, were showing hose of all kinds and sizes, suction, delivery, pneumatic tool and rock drill, diving and dredging. Belting—transmission, elevator and conveyor was also exhibited and a variety of mechanical rubbers.

Petters, Ltd., of Westland Works, Yeovil, Somerset, in a display of their oil engines were making a special feature of a new design known as the Atomic Diesel, that exhibited being of 50 b.h.p. It is an airless and springless injection cold-starting engine which will operate on a wide range of fuel oils. It is built in sizes up to 260 b.h.p.

Crossley Bros., Ltd., of Openshaw, Manchester, were showing two large marine auxiliary power sets, one a 5 cylinder Diesel engine with a normal rating of 137 b.h.p. at 450 r.p.m. direct coupled to a Metropolitan-Vickers generator and a 4 cylinder heavy oil engine, enclosed horizontal type, with a normal rating of 80 b.h.p. at 375 r.p.m.

The Parsons Oil Engine Co., Ltd., of Town Quay Works, Southampton, among a range of oil engines were showing for the first time one of their M series of different sizes of 4, 6, and 8 cylinders respectively, providing outputs of from 35 to 100 b.h.p. on paraffin, or from 50 to 200 b.h.p. on petrol, and speed ranges of 1,000 to 2,000 r.p.m.

The Mond Nickel Co., Ltd. (The Bureau of Information on Nickel), of Imperial Chemical House, Millbank, London, S.W. 1, had an exhibit illustrating by means of representative products and photographs the increasing part which nickel is taking in a great number of industries, prominence being given to the alloys of copper and nickel.

Lacy-Hulbert and Co., Ltd., of Boreas Works, Beddington, Croydon, were showing high speed air-compressors such as are built in eight sizes with outputs varying from 1 to 85 cu. ft. of free air per minute and suitable for pressures up to 150 lb. per square inch, also portable petrol and electric air-compressors, rotary pumps, pneumatic tools and other accessories.

Robey and Co., Ltd., of Globe Works, Lincoln, were displaying their horizontal cold-starting oil engine which embodies a number of special features including an eccentric drive for operating the air and exhaust valves and a spring relief valve for relieving excess pressure in the cylinder and a new type of atomiser. These engines are built for powers ranging from 15 to 200 b.h.p.

Huntington, Heberlein and Co., Ltd., of 47-51, King William Street, London, E.C. 4, were showing their " H. H." jigging screens and also their " Overstrom " vibrating screen, the former consists of a steel body carrying the screen frame mounted on a series of laminated spring legs, the mechanism being actuated by an unbalanced pulley. The latter is similarly actuated at 1,800 r.p.m., which gives a vigorous vibration of small amplitude.

Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, London, W. 4, among a large exhibit of electrical instruments were making a feature of the Bridge-Meg resistance tester described in these columns last month. In conjunction with Glenfield and Kennedy they were also showing a Midworth distant repeater, the purpose of which is to repeat at a distance the movement of apparatus and in this case it is shown controlling the operation of a large hydraulic valve.

Thos. Firth and Sons, Ltd., of Norfolk Works, Sheffield, were showing a wide range of applications of stainless steel for such purposes as turbine blades, valve spindles and others. Staybrite steel also formed a large part of their exhibit. H.R. Crown Heat Resisting steel and aircraft steels were shown. With regard to the last named, it is of interest to record that these were largely used in the recent engines with which the British Schneider Trophy seaplanes were fitted.

Rubber Growers' Association (Inc.), of 2–4, Idol Lane, Eastcheap, London, E.C. 3, had an exhibit arranged in collaboration with rubber manufacturers designed to show the various applications of rubber and to give an idea of the research which is carried out to find further applications. Particularly important is the use of rubber to resist corrosion and abrasion, for shock and vibration absorption, for electrical insulation, and for belting, hose, packings and jointings.

Rotary Air Compressor Co., Ltd., of 12, Victoria Street, Westminster, S.W. 1, were showing their machines which are designed on the crescent-principle and are provided with floating rings which prevent the wear of the blades upon the casing. Single-stage compressors of this design are suitable for working pressures up to 60 lb. per square inch and the two-stage machines for pressures up to 120 lb. per square inch. They are made in sizes ranging from 5 cu. ft. to 7,000 cu. ft. of free air per minute.

Holman Bros., Ltd., of Camborne, England, were showing several Hele-Shaw Beacham air motors in five different sizes having horse powers ranging from 5 to 45, which were coupled to centrifugal pumps, ventilating fans and air-driven hoists. Air to operate these motors is supplied by an electrically driven air-compressor. They were also showing a portable compressor set, comprising a Hele-Shaw Beacham rotary compressor of 162 cu. ft. displacement at 1,500 r.p.m. driven by a Dorman petrol engine.

Hadfields, Ltd., of East Hecla Works, Sheffield, were making a main feature of special steels for high-temperature engineering. These included their Hecla/ATV steel, suitable for turbine blading and steam fittings, and Era heat resisting steels which are chiefly remarkable for their resistance to scaling and the effect of sulphurous gases at high temperatures. Castings were exhibited in Era manganese steel for dredge components and wearing parts, Era/CR steels resistant to sea water and chemical agents, and other special steels.

W. Sisson and Co., Ltd., of Elmbridge Road, Gloucester, were exhibiting examples of the "Sisson" high speed steam engine, both land and marine types, particular importance attaching to that design especially intended as a power unit for a tin or other dredge. This is arranged with patent reversible gear and automatic expansion and compression shaft governor, giving steam economy under wide range of load. The design is specially massive to stand the heavy duty and continuous running. Interest also attaches to the fact that the *Discovery*, which is carrying the Mawson expedition to the Antarctic, is also equipped with one of these engines.

Wingrove and Rogers, Ltd., of Arundel Chambers, Strand, London, W.C. 2, were showing electric and petrol driven trucks and locomotives. Among these may be particularly mentioned the two ton electric truck for heavy duty, electric locomotive for rail guages of 18 in. and upwards, loads of from 5 to 20 tons, and a newly designed petrol truck of one ton capacity. They send us additional particulars regarding the first named. This two ton truck is capable of a speed of five miles per hour, has a radius of action of 15 to 20 miles per charge, has a loading space of 7 ft. 6 in. by 3 ft. 7 in., and has solid rubber tyres moulded on to steel bands and pressed on to wheel centres.

METAL MARKETS

Copper.—This market opened September in a vigorous fashion. America set the pace, heavy buying being reported there both on domestic and export account, and sales by producers during the early days of the month were said to have been at a record rate. Standard values in London were consequently firm, and this tendency was accentuated when some of the American interests tried to advance the New York price of electrolytic. The latter did at one time harden from its previous level of 18 cents to 18·25 cents per lb., but most producers appeared to be indisposed to demand the higher figure, and the quotation dropped again to 18 cents. Throughout the latter half of the month the standard market was rather quiet and distinctly easier. The outlook is rather obscure, but producers of refined copper are probably fairly comfortably off for business. Their surplus stocks were recently expanding, despite the curtailment of output, but now that industrial buying is increasing thanks to the advent of autumn, this tendency may soon be reversed.

Average price of standard cash copper: September, 1929, £75 6s. 9d.; August, 1929, £73 16s. 8d.; September, 1928, £63 11s. 3d.; August, 1928, £62 10s. 2d.

Tin.—This was a disappointing market throughout September, despite a certain amount of support accorded to it by the big bull group. Consuming demand remained good but nevertheless it was clear that, as a result of the speeding-up in output, there was too much metal about for actual needs. It is possible, but by no means certain, that the autumn and winter may see an increased demand, in which case values might improve. Of course, the quotation now looks very moderate, and this fact alone might conceivably induce speculators to support the market. At present, however, financial conditions do not seem to be favourable to speculative operations. The incomplete Tin Producers' Association does not appear to have had any tangible influence on the market so far.

Average price of cash standard tin: September, 1929, £204 18s. 9d.; August, 1929, £209 17s. 11d.; September, 1928, £215 15s. 7d.; August, 1928, £212 19s. 10d.

Lead.—The London lead market was fairly steady throughout September, thanks mainly to the existence of the Lead Producers' Association, which now controls the European position fairly efficiently. Despite the fact that industrial demand was dull all over Europe and that arrivals of fresh metal into the United Kingdom were plentiful, there was no pressure of supplies as far as the market was concerned. In America conditions seemed more active, however, and at the beginning of the month the quotation in New York was advanced from 6·75 cents to 6·90 cents per lb.

Average mean price of soft foreign lead: September, 1929, £23 11s. 5d.; August, 1929, £23 4s. 5d.; September, 1928, £21 18s. 2d.; August, 1928, £21 12s. 7d.

Spelter.—This market was easy during September, particularly towards the end of the month, when prompt spelter fell below the price of prompt lead. Industrial interest was poor, and sentiment was shaken by the fact that at the meeting, which occurred during the month, producers took no fresh steps to assist the situation. In view of the fact, however, that makers have already curtailed output pretty substantially without reaping much benefit from it, it is not perhaps surprising that they should not be eager to take further action in this regard. What the market really needs is undoubtedly a marked revival in consuming demand, which so far shows but few signs of manifesting itself.

Average mean price of spelter: September, 1929, £24 8s. 11d.; August, 1929, £25 0s. 7d.; September, 1928, £24 11s. 2d.; August, 1928, £24 12s. 6d.

Iron and Steel.—The Cleveland pig-iron market continued to present a satisfactory aspect during September, although business was quiet until towards the close of the month. Delivery delays have tended to shrink and merchants seem no longer able to exact premiums for prompt material. The situation is likely, however, to become more stringent again with the advent of autumn and winter. No. 3 Cleveland pig-iron remains quoted at 72s. 6d. Hematite has tended to harden, although East Coast Mixed Nos. at 76s. 6d. are still well below production-cost. Finished iron and steel was quiet but firm during the month. Some of the British works could do with more business to keep them satisfactorily employed. Continental steel was generally dull and easy.

Antimony.—At the close of the month English regulus was quoted at £47 10s. to £52 10s. per ton. Chinese was dull at about £31 10s. to £32 ex warehouse and £30 to £30 5s. c.i.f. for shipment from China.

LONDON DAILY METAL PRICES

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD.
	STANDARD.		ELECTROLYTIC.	BEST SELECTED.				SOFT FOREIGN.	ENGLISH.	Cash.	Forward.	
	Cash.	3 Months.			Cash.	3 Months.						
Sept.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	76 5 0	76 13 9	84 15 0	—	204 7 6	208 6 3	24 7 6	23 8 9	24 15 0	$23\frac{13}{16}$	$23\frac{7}{8}$	84 11½
12	76 15 0	77 5 0	84 15 0	—	204 11 3	208 11 3	24 3 9	23 10 0	24 15 0	$23\frac{3}{4}$	$23\frac{15}{16}$	84 11½
13	75 16 3	76 3 1½	84 15 0	79 15 0	205 2 6	208 18 9	24 6 3	23 8 9	25 0 0	$23\frac{11}{16}$	$23\frac{3}{4}$	84 11½
16	75 3 1½	75 10 7½	84 15 0	—	205 13 9	209 13 9	24 6 3	23 8 9	25 0 0	$23\frac{9}{16}$	$23\frac{5}{8}$	84 11½
17	74 3 9	74 13 9	84 10 0	79 0 0	205 8 9	209 6 3	24 6 3	23 10 0	25 0 0	$23\frac{9}{16}$	$23\frac{5}{8}$	84 11½
18	74 13 9	75 3 1½	84 10 0	—	204 8 9	208 3 9	24 8 9	23 10 0	25 0 0	$23\frac{1}{2}$	$23\frac{9}{16}$	84 11½
19	74 11 10½	75 3 1½	84 10 0	—	204 8 9	208 3 9	24 7 6	23 12 6	25 0 0	$23\frac{1}{2}$	$23\frac{9}{16}$	84 11½
20	74 11 3	75 1 3	84 10 0	79 0 0	205 3 9	209 3 9	24 7 6	23 11 3	25 0 0	$23\frac{1}{2}$	$23\frac{9}{16}$	84 11½
23	74 1 3	74 11 10½	84 10 0	—	205 15 0	209 11 3	24 1 3	23 12 6	25 0 0	$23\frac{7}{16}$	$23\frac{7}{16}$	84 11½
24	74 6 10½	74 16 3	84 10 0	79 0 0	205 8 9	209 6 3	24 0 0	23 13 9	25 0 0	$23\frac{1}{2}$	$23\frac{1}{2}$	84 11½
25	74 0 7½	74 11 3	84 10 0	—	204 15 0	208 11 3	23 17 6	23 12 6	25 0 0	$23\frac{11}{16}$	$23\frac{11}{16}$	84 11½
26	73 16 10½	74 9 4½	84 10 0	—	203 6 3	207 8 9	23 11 3	23 13 9	25 0 0	$23\frac{9}{16}$	$23\frac{5}{8}$	84 11½
27	74 3 9	74 15 7½	84 10 0	78 5 0	203 8 9	207 8 9	23 10 0	23 12 6	25 0 0	$23\frac{5}{16}$	$23\frac{3}{8}$	84 11½
30	74 1 10½	74 13 1½	84 10 0	—	203 3 9	207 3 9	23 10 0	23 12 6	25 0 0	$23\frac{3}{16}$	$23\frac{1}{4}$	84 11½
Oct.												
1	73 8 9	73 18 9	84 5 0	77 10 0	200 3 9	203 8 9	23 12 6	23 7 6	25 0 0	$23\frac{5}{16}$	$23\frac{3}{8}$	84 11
2	73 15 7½	74 4 4½	84 7 6	—	196 2 6	200 2 6	23 13 9	23 7 6	25 0 0	$23\frac{1}{4}$	$23\frac{3}{8}$	84 11½
3	73 15 0	74 9 4½	84 10 0	—	198 18 9	202 16 3	23 17 6	23 7 6	25 0 0	$23\frac{1}{4}$	$23\frac{1}{4}$	84 11½
4	73 16 10½	74 8 1½	84 10 0	77 10 0	198 11 3	202 6 3	23 17 6	23 5 0	24 15 0	$23\frac{1}{4}$	$23\frac{1}{4}$	84 11½
7	74 3 1½	74 14 4½	84 10 0	—	198 13 9	202 11 3	23 16 3	23 5 0	24 15 0	$23\frac{7}{16}$	$23\frac{9}{16}$	84 11½
8	74 14 4½	75 1 10½	84 10 0	78 15 0	196 12 6	200 11 3	23 15 0	23 5 0	24 15 0	$22\frac{15}{16}$	$23\frac{1}{16}$	84 10½
9	74 9 4½	74 16 3	84 10 0	—	196 11 3	200 11 3	23 12 6	23 5 0	24 15 0	$22\frac{15}{16}$	$23\frac{1}{16}$	84 11½
10	73 12 5	74 3 2½	84 10 0	—	195 17 6	200 1 3	23 7 6	23 6 3	24 15 0	$23\frac{1}{16}$	$23\frac{3}{16}$	84 11½

Iron Ore.—Generally speaking this market wears a very firm appearance, but with buyers so fully covered, any odd parcels that happen to come on to the market have to be realized at a discount from the ruling quotation of about 24s. 6d. per ton c.i.f., for best Bilbao rubio.

Arsenic.—In this country business is still somewhat moderate, but better advices are received from the United States and the undertone is a little firmer. Mexican is now held for higher prices, but 99 per cent Cornish white remains at £16 per ton f.o.r. mines.

Bismuth.—A steady business is passing at the official price of 7s. 6d. per lb. for merchant quantities.

Cadmium.—There was a period of quiet trade early in September, but prices keep steady at about 3s. 10d. to 3s. 11d. per lb.

Cobalt Metal.—A fair demand continues in evidence, with the official price unaltered at 10s. per lb.

Cobalt Oxides.—Quotations are without change at 8s. per lb. for black and 8s. 10d. for grey oxide.

Platinum.—Business has not attained very substantial proportions but the market seems very steady, with refined metal quoted at £13 10s. to £13 15s. per oz. Some seasonal demand from the jewellery trade is about due.

Palladium.—The turnover remains small, but prices are steady at about £7 to £7 5s. per oz.

Iridium.—Easier conditions have characterized this market recently, and sponge and powder are now about £43 to £46 per oz.

Tellurium.—Prices can only be called nominal in the neighbourhood of 12s. 6d. to 15s. per lb.

Selenium.—This market keeps remarkably steady at 7s. 8d. to 7s. 9d. per lb. ex warehouse for 99 per cent black powder.

Manganese Ore.—Early in September there was some very heavy forward buying, several hundred thousand tons being booked for 1930 delivery. Russia has sold very substantial quantities for next year, while the surplus West African output also had been sold. It is interesting to note that contracts have been placed for South African Postmasburg ore for shipment from March, 1930, onwards. Prices, however, are none too firm, for there is still plenty of ore available, and washed Caucasian is no better than 1s. 0½d. per unit c.i.f., while best Indian is nominally held at 1s. 1½d. to 1s. 1¾d. per unit c.i.f.

Aluminium.—Fresh business has been quiet, but consumption generally is well maintained, and the market is fully steady at £95 delivered, less 2% for ingots and bars.

Sulphate of Copper.—English material still stands at about £27 to £27 10s. per ton, less 5%.

Nickel.—Consumption remains large, and supplies are very well absorbed. Prices are unaltered at £175 per ton for both home and export business.

Chrome Ore.—Supplies are plentiful, although demand is still quite good. Rhodesian 48% ore remains at about £4 5s. per ton c.i.f.

Quicksilver.—The turnover is still rather restricted, and spot material now stands at about £22 10s. per bottle, after having been slightly dearer.

Tungsten Ore.—Early in September demand fell away to practically nothing, but latterly a little more interest has been shown, and after falling to about 30s. per unit c.i.f. for forward shipment material, quotations have recovered to about 35s. to 36s. for October–November–December shipment from China.

Molybdenum Ore.—American 80% concentrates are offering at about 37s. 6d. per unit c.i.f., but 85% Australian material is held for higher figures.

Graphite.—A fair demand is reported at around £25 to £28 per ton c.i.f. for 85 to 90% Madagascar flake, and £25 to £26 c.i.f. for 90% Ceylon lumps.

Silver.—During September the silver market made a very poor showing. On September 2 spot bars stood at $24\frac{3}{16}$d. but with better news regarding the internal situation in China an easier tone developed, and India offered little support except at low prices. By September 16 spot bars had fallen to $23\frac{9}{16}$d., while further weakness was apparent during the closing days of the month and on September 30 spot bars closed at $23\frac{3}{16}$d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
September, 1928	819,341	38,390	857,731
October	858,945	38,775	897,720
November	832,461	40,023	872,484
December	821,582	38,179	859,761
January, 1929	840,344	36,108	876,452
February	778,559	36,725	815,284
March	830,829	35,700	866,529
April	836,474	35,649	872,123
May	858,991	38,607	897,598
June	821,352	34,677	856,029
July	853,370	36,110	889,480
August	850,952	38,649	889,601
September	814,707	34,846	849,553

TRANSVAAL GOLD OUTPUTS.

	August.		September.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	83,500	£141,846	84,000	£138,545
City Deep	91,000	25,023	80,500	23,590
Cons. Main Reef	61,000	22,616	57,300	21,562
Crown Mines	240,000	75,650	227,000	72,087
D'rb'n Roodepoort Deep	41,600	14,251	40,400	13,845
East Rand P.M.	148,500	40,218	145,200	38,844
Geduld	86,100	27,174	83,500	26,758
Geldenhuis Deep	67,500	15,210	63,400	14,694
Glynn's Lydenburg	6,600	2,116	6,100	1,790
Government G.M. Areas	210,000	£397,551	194,000	£370,322
Kleinfontein	50,900	10,496	50,600	10,315
Langlaagte Estate	87,000	£113,987	78,000	£107,470
Luipaard's Vlei	24,800	6,213	22,800	5,946
Meyer and Charlton	17,300	£19,866	16,800	£19,649
Modderfontein New	154,000	74,477	146,000	70,789
Modderfontein B	71,500	25,429	69,000	24,511
Modderfontein Deep	45,900	24,237	42,800	22,743
Modderfontein East	68,500	20,744	66,000	20,188
New State Areas	79,003	£139,673	71,000	£133,616
Nourse	61,400	17,801	56,000	16,933
Randfontein	218,000	£223,396	212,000	£210,474
Robinson Deep	80,000	21,401	75,500	20,715
Rose Deep	60,000	12,432	58,000	11,922
Simmer and Jack	74,600	18,301	76,000	18,894
Springs	71,500	£148,033	66,900	£136,949
Sub Nigel	26,000	23,764	25,200	20,831
Transvaal G.M. Estates	15,100	5,035	14,170	4,910
Van Ryn	40,300	£40,481	40,000	£39,954
Van Ryn Deep	62,000	£104,565	59,000	£102,007
Village Deep	60,000	15,929	57,700	15,513
West Rand Consolidated	90,000	£96,691	87,000	£96,744
West Springs	66,000	£81,264	63,500	£77,455
Witw'tersr'nd (Knights)	57,000	£49,412	53,000	£48,665
Witwatersrand Deep	45,200	12,934	42,000	9,094

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.	£
July, 1928	2,528,600	27 11	19 8	8 3	1,048,432
August	2,580,700	27 11	19 7	8 4	1,079,152
September	2,485,700	27 11	19 7	8 4	1,040,368
October	2,612,500	27 9	19 5	8 4	1,092,162
November	2,539,700	27 9	19 7	8 2	1,041,713
December	2,505,500	27 10	19 8	8 2	1,024,654
January, 1929	2,627,320	28 1	19 9	8 4	1,095,070
February	2,403,720	28 6	20 3	8 3	990,942
March	2,581,600	28 3	20 0	8 3	1,062.331
April	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	—	—	—	—	1,111,834

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
September 30, 1928	194,936	16,724	4,535	215,843
October 31	193,147	16,767	4,807	216,362
November 30	190,370	16,803	4,889	216,628
December 31	187,970	16,059	4,444	208,473
January 31, 1929	192,526	15,845	50,56	213,427
February 28	196,150	15,940	5,635	217,725
March 30	197,646	16,065	5,787	219,498
April 30	197,412	15,900	5,554	218,866
May 31	195,733	15,852	5,473	217,058
June 30	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

PRODUCTION OF GOLD IN RHODESIA.

	1926	1927	1928	1929
	oz.	oz.	oz.	oz.
January	48,967	48,731	51,356	46,231
February	46,026	46,461	46,286	44,551
March	46,902	50,407	48,017	47,388
April	51,928	48,290	48,549	48,210
May	49,392	48,992	47,323	48,189
June	52,381	52,910	51,762	48,406
July	50,460	49,116	48,960	46,369
August	49,735	47,288	50,611	46,473
September	48,350	45,838	47,716	—
October	50,132	46,752	43,056	—
November	51,090	47,435	47,705	—
December	48,063	49,208	44,772	—

RHODESIAN GOLD OUTPUTS.

	August.		September.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,000	11,079	24,200	11,167
Globe and Phœnix	6,003	4,474	6,002	4,966
Lonely Reef	5,300	4,096	5,300	4,150
Rezende	6,400	2,904	6,400	2,890
Shamva	46,000	£23,789	40,000	£20,394
Sherwood Starr	5,000	£8,864	5,000	£9,353

WEST AFRICAN GOLD OUTPUTS.

	August.		September.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	—	—	—	—
Ashanti Goldfields	9,063	10,709	9,121	10,794
Taquah and Abosso	8,410	£13,893	8,010	£13,325

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.	New South Wales.
	Oz.	Oz.	Oz.	Oz.
September, 1928	32,397	3,366	644	364
October	36,565	2,632	820	256
November	31,466	3,111	865	550
December	36,097	—	493	208
January, 1929	27,384	—	260	445
February	28,177	1,997	117	474
March	25,848	2,974	816	—
April	39,166	—	617	—
May	28,026	3,018	493	467
June	33,139	2,368	465	80
July	28,086	1,421	1,203	—
August	37,032	—	—	—
September	32,751	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	August.		September.	
	Tons	Value £	Tons	Value £
Associated G.M. (W.A.)	5,250	9,028	4.767	7,870
Blackwater (N.Z.)	3,230	5,538	2,095	5,227
Boulder Persev'ce (W.A.)	6,100	17,208	5,936	15,706
Grt. Boulder Pro. (W.A.)	9,836	27,776	—	—
Lake View & Star (W.A.)	7,307	18,166	—	—
Sons of Gwalia (W.A.)	14 220	11,367	13,640	11,959
South Kalgurli (W.A.)	8,962	16,791	8,585	16,439
Waihi (N.Z.)	17,945	6,083* 37,851†	18,146	6,633* 35,910†

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	August.		September.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,500	2,745	3,900	2,753
Champion Reef	8,510	5,616	8,415	5,931
Mysore	18,552	8,405	18,327	8,325
Nundydroog	11,000	6,677	10,847	6,682
Ooregum	14,000	6,237	13,865	6,187

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	August.		September.	
	Tons	Value £	Tons	Value £
Chosen Synd. (Korea)	9,100	12,010	—	—
Frontino& Bolivia (C'lbia)	1,790	4,823	1,810	6,284
Lena (Siberia)	—	27,800	—	—
Lydenburg Plat. (Trans.)	3,620	638*p*	3,370	737
Marmajito (Colombia)	710	£3,690	760	3,389
Mexican Corp. Fresnillo	92,453	147,523*d*	—	—
Onverwacht Platinum	2,440	452*p*	2,384	434*p*
Oriental Cons. (Korea)	17,488	87,500*d*	19,244	88,913*d*
St. John del Rey (Brazil)	—	41,000	—	46,600
Santa Gertrudis (Mexico)	51,477	108,801*d*	—	—

d dollars. *p* Oz. platinoids.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1929	5,840	July, 1929	5,802
February	4,896	August	5,610
March	5,236	September	5,332
April	5,433	October	—
May	5,405	November	—
June	5,523	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Batu Caves	46	31	30
Changkat	75	120	—
Chenderiang	27	30	27
Gopeng	83	80	86
Hong Kong Tin	—	42	50½
Idris Hydraulic	35¾	32¾	32¾
Ipoh	41¾	37	43¼
Jelapang	36	42	—
Kamunting	103	83½	84
Kent (F.M.S.)	48	36	39
Kepong	36	34	34
Kinta	31	30	30
Kinta Kellas	47½	38¾	32¾
Kramat Pulai	17¾	19¼	13¾
Kuala Kampar	115	120	—
Kundang	15	—	—
Lahat	12⅜	11⅛	12¼
Larut Tinfields	82	81	—
Malaya Consolidated	41¾	70½	53¼
Malayan Tin	119	125	143
Meru	25	27	27¼
Pahang	222	222	222
Pengkalen	89	86	77½
Petaling	184½	202½	226
Rahman	53½	53½	53½
Rambutan	11	11	10
Rantau	35	43	32
Rawang	55	50	—
Renong	66½	49¾	44¾
Selayang	23	17½	20¼
Southern Malayan	184½	184½	172½
Southern Perak	86¼	65½	59½
Southern Tronoh	21	18	21
Sungei Besi	48	45	45
Sungei Kinta	28	42¼	68½
Sungei Way	89¼	89¼	83¼
Taiping	75	40	31
Tanjong	34	27	30
Teja Malaya	20¾	18¼	5
Tekka	45	46	45
Tekka-Taiping	45	39	27
Temoh	37¾	43	35¾
Tronoh	108	133	99

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Amari	9¾	14	—
Anglo-Nigerian	47	40	—
Associated Tin Mines	260	250	—
Baba River	3	6	—
Batura Monguna	2	2½	—
Bisichi	76	90	92
Daffo	9	10	—
Ex-Lands	50	55	—
Filani	5	11½	8
Jantar	52	45	40
Jos	19	19	—
Juga Valley	20	20	—
Junction	4	2½	—
Kaduna	31¾	51	—
Kaduna Prospectors	21¼	32½	—
Kassa	20	26	—
Lower Bisichi	6¼	9½	—
Mongu	40	60	—
Naraguta	45	76	—
Naraguta Durumi	12	20	20
Naraguta Extended	25	25	25
Naraguta Karama	21	38½	—
Naraguta Korot	20	20	—
Nigerian Base Metals	34	46½	—
Nigerian Consolidated	20	20	20
N.N. Bauchi	140	120	—
Offin River	4¾	5¼	4
Ribon Valley	15	23	—
Ropp	90	105	—
Rukuba	5½	—	—
South Bukeru	9½	8	7½
Tin Fields	7	8	6¾
Tin Properties	20	20	—
United Tin Areas	23	29¾	—
Yarde Kerri	10	10	9

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	July.	August.	Sept.
Anglo-Burma (Burma)	20½	30¼	—
Aramayo Mines (Bolivia)	374	332	—
Bangrin (Siam)	64½	76½	69¼
Berenguela (Bolivia)	38	31	41
C'nsolidated Tin Mines (Burma)	150	200	150
East Pool (Cornwall)	85½	88¼	—
Fabulosa (Bolivia)	124¼	120	145
Geevor (Cornwall)	71	72	69
Jantar (Cornwall)	25¼	24	—
Kagera (Uganda)	28	28	28
Polhigey (Cornwall)	33	30	—
San Finx (Spain)	39½*	37¼*	—
Siamese Tin (Siam)	169	159¼	143½
South Crofty (Cornwall)	65¼	69	68¾
Tavoy Tin (Burma)	40	41	—
Theindaw (Burma)	8	9	—
Tongkah Harbour (Siam)	85	97	100
Toyo (Japan)	—	—	—
Wheal Kitty (Cornwall)	36	36	—
Wheal Reeth (Cornwall)	13½	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		August.	Sept.
Broken Hill South	Tons lead conc.	3,079*	5,947
	Tons zinc conc.	2,575*	5,236
Burma Corporation	Tons refined lead	6,505	6,502
	Oz. refined silver	600,194	600,837
Bwana M'Kubwa	Tons copper oxide	663	605
Electrolytic Zinc	Tons zinc	3,925	4,036‡
Indian Copper	Tons copper	185	175
Messina	Tons copper	587	557
Mount Lyell	Tons concentrates	3,769†	—
Namaqua	Tons copper	200	188
North Broken Hill	Tons lead conc.	8,850	—
	Tons zinc conc.	6,670	—
Poderosa	Tons copper ore	1,352	1,020
Rhodesia Broken Hill	Tons lead	—	—
	Tons slab zinc	1,085	1,125
San Francisco Mexico	Tons lead conc.	2,567	3,097
	Tons zinc conc.	3,091	4,036
Sulphide Corporation	Tons lead conc.	1,834	1,738
	Tons zinc conc.	2,425	2,313
Tetiube	Tons lead conc.	577	—
	Tons zinc conc.	1,182	—
Union Minière	Tons copper	12,200	—
Zinc Corporation	Tons lead conc.	5,542	—
	Tons zinc conc.	4,006	—

* Four weeks to Sept. 7. † Four weeks to Sept. 11. ‡ Four weeks to Sept. 18.

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

		July.	August.
Iron Ore	Tons	480,858	576,166
Manganese Ore	Tons	21,583	29,908
Iron and Steel	Tons	237,220	255,192
Copper and Iron Pyrites	Tons	21,805	25,298
Copper Ore, Matte, and Prec.	Tons	4,869	2,611
Copper Metal	Tons	13,798	14,565
Tin Concentrate	Tons	5,150	8,433
Tin Metal	Tons	1,639	1,111
Lead Pig and Sheet	Tons	22,943	29,268
Zinc (Spelter)	Tons	10,634	13,830
Zinc Sheets, etc.	Tons	1,577	1,891
Aluminium	Tons	2,259	1,680
Quicksilver	Lb.	16,777	49,423
Zinc Oxide	Tons	1,054	913
White Lead	Cwt.	9,996	13,742
Red and Orange Lead	Cwt.	5,355	2,530
Barytes, ground	Cwt.	64,046	57,415
Asbestos	Tons	1,440	3,117
Boron Minerals	Tons	1,298	—
Borax	Cwt.	17,133	22,477
Basic Slag	Tons	1,515	997
Superphosphates	Tons	3,303	2,224
Phosphate of Lime	Tons	19,647	33,462
Mica	Tons	187	433
Sulphur	Tons	12,649	7,768
Nitrate of Soda	Cwt.	22,626	10,550
Potash Salts	Cwt.	160,052	429,696
Petroleum: Crude	Gallons	63,607,149	43,866,394
Lamp Oil	Gallons	11,355,771	19,632,199
Motor Spirit	Gallons	70,054,633	85,539,434
Lubricating Oil	Gallons	7,941,437	10,788,760
Gas Oil	Gallons	9,670,655	6,919,791
Fuel Oil	Gallons	39,165,639	44,545,546
Asphalt and Bitumen	Tons	20,544	13,492
Paraffin Wax	Cwt.	101,569	134,705
Turpentine	Cwt.	49,221	65,318

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES
In Tons.

	July.	August.	Sept.
Anglo-Ecuadorian	16,047	16,085	14,961
Apex Trinidad	38,040	34,200	34,610
Attock	4,839	7,329	5,429
British Burmah	6,021	5,930	—
British Controlled	33,174	34,547	—
Kern Mex	736	835	891
Kern River (Cal.)	5,074	5,021	4,702
Kern Romana	3,771	6,013	5,170
Kern Trinidad	4,006	4,521	5,095
Lobitos	27,763	27,805	26,954
Phœnix	41,853	44,271	42,276
St. Helen's Petroleum	19,887	13,333	12,091
Steaua Romana	75,920	83,480	78,970
Tampico	2,753	3,076	3,226
Trinidad Leaseholds	31,000	33,550	31,450
Venezuelan Consolidated	5,128	4,224	—

QUOTATIONS OF OIL COMPANIES SHARES.
Denomination of Shares £1 unless otherwise noted.

	Sept. 9, 1929			Oct. 9, 1929		
	£	s.	d.	£	s.	d.
Anglo-American	3	2	6	3	1	3
Anglo-Ecuadorian	1	0	6	1	0	0
Anglo-Egyptian B	2	12	6	2	12	6
Anglo-Persian 1st Pref.	1	6	0	1	5	6
,, ,, Ord.	4	5	6	4	5	6
Apex Trinidad (5s.)	1	10	0	1	8	9
Attock	2	19	6	2	14	6
British Burmah (8s.)		6	9		7	0
British Controlled ($5)		5	3		5	6
Burmah Oil	4	5	6	4	5	0
Kern River, Cal. (10s.)		7	9		6	6
Lobitos, Peru	2	3	0	2	1	9
Mexican Eagle, Ord. (4 pesos)		16	9		16	9
,, ,, 8% Pref. (4 pesos)		15	9		16	6
Phœnix, Roumania		11	6		11	0
Royal Dutch (100 fl.)	34	17	6	37	6	3
Shell Transport, Ord.	4	17	6	4	18	9
,, ,, 5% Pref. (£10)	9	15	0	9	6	3
Steaua Romana		10	9		10	6
Trinidad Leaseholds	4	5	6	4	5	6
United British of Trinidad (6s. 8d.)		9	6		8	6
V.O.C. Holding	3	15	0	3	10	6

PRICES OF CHEMICALS. October 5.

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	0
,, 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.	,,	9	11	0
Antimony, Tartar Emetic	per lb.			10¾
,, Sulphide, Golden	,,			7
Arsenic, White	per ton	16	0	0
Barium Carbonate, 94%	,,	5	10	0
,, Chloride	per ton	12	0	0
,, Sulphate, 94%	,,	5	0	0
Benzol, standard motor	per gal.		1	9½
Bleaching Powder, 35% Cl.	per ton	7	0	0
,, Liquor, 7%	,,	3	5	0
Borax	,,	14	0	0
Boric Acid	,,	25	0	0
Calcium Chloride		5	10	0
Carbolic Acid, crude 60%	per gal.		2	3
,, ,, crystallized, 40°	per lb.			7½
Carbon Disulphide	per ton	24	0	0
Citric Acid	per lb.		2	1
Copper Sulphate	per ton	26	0	0
Cyanide of Sodium, 100% KCN	per lb.			7
Hydrofluoric Acid	,,			6
Iodine	per oz.		1	0
Iron, Nitrate	per ton	6	10	0
,, Sulphate	,,	1	17	6
Lead, Acetate, white	,,	39	10	0
,, Nitrate	,,	34	0	0
,, Oxide, Litharge	,,	37	10	0
,, White		38	0	0
Lime, Acetate, brown		8	0	0
,, ,, grey, 80%		16	10	0
Magnesite, Calcined		9	10	0
Magnesium, Chloride	,,	6	15	0
,, Sulphate	,,		5	0
Methylated Spirit 64° Industrial	per gal.		[illegible]	5
Nitric Acid, 80° Tw.	per ton			0
Oxalic Acid	per cwt.			
Phosphoric Acid	per ton			
Potassium Bichromate	per lb.			
,, Carbonate	per ton	2[illegible]		
,, Chlorate	per lb.			
,, Chloride 80%	per ton	9		
,, Hydrate (Caustic) 90%	,,	32		
,, Nitrate, refined	,,	20	10	
,, Permanganate	per lb.			
,, Prussiate, Yellow	,,			[illegible]
,, ,, Red	,,		1	9
,, Sulphate, 90%	per ton	11	5	0
Sodium Acetate	per ton	20	10	0
,, Arsenate, 45%	,,	26	0	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3⅜
,, Carbonate (Soda Ash)	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	per lb.			2½
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite	,,	9	0	0
,, Nitrate, 96%	,,	9	11	0
,, Phosphate	,,	11	0	0
,, Prussiate	per lb.			4¾
,, Silicate	per ton	9	10	0
,, Sulphate (Salt-cake)	,,	2	15	0
,, ,, (Glauber's Salt)	,,	2	0	0
,, Sulphide	,,	9	0	0
Sulphur, Roll	,,	10	10	0
,, Flowers	,,	12	0	0
Sulphuric Acid, 168°	,,	6	5	0
,, ,, free from Arsenic, 144°	,,	4	0	0
Superphosphate of Lime, 35%	,,	3	0	0
Tartaric Acid	per lb.		1	4½
Turpentine	per ton	47	0	0
Tin Crystals	per lb.		1	6½
Titanous Chloride	,,			10
Zinc Chloride	per ton	12	0	0
Zinc Dust	,,	32	0	0
Zinc Oxide	,,	42	0	0
Zinc Sulphate	,,	9	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Sept. 9, 1929. £ s. d.	Oct. 9, 1929. £ s. d.
SOUTH AFRICA:		
Brakpan	4 6 3	4 4 6
City Deep	13 3	10 6
Consolidated Main Reef	18 6	18 6
Crown Mines (10s.)	3 4 6	3 4 6
Daggafontein	1 2 6	1 2 6
Durban Roodepoort Deep	11 3	11 3
East Geduld	2 0 0	1 18 9
East Rand Proprietary (10s.)	13 9	12 0
Ferreira Deep	6 3	6 3
Geduld	3 8 9	3 6 3
Geldenhuis Deep	5 0	4 9
Glynn's Lydenburg	2 6	2 6
Government Gold Mining Areas (5s.)	1 17 6	1 17 0
Langlaagte Estate	1 0 9	1 0 6
Meyer & Charlton	10 0	10 0
Modderfontein New (10s.)	5 3 0	4 16 3
Modderfontein B (5s.)	16 3	14 6
Modderfontein Deep (5s.)	1 7 6	1 7 0
Modderfontein East	1 7 6	1 5 6
New State Areas	1 12 6	1 12 6
Nourse	9 6	8 9
Randfontein	8 0	6 9
Robinson Deep A (1s.)	13 9	13 9
,, ,, B	9 0	8 6
Rose Deep	6 3	5 6
Simmer & Jack (2s. 6d.)	3 9	3 6
Springs	3 4 6	3 2 6
Sub Nigel (10s.)	2 0 0	1 15 6
Van Ryn	8 0	7 6
Van Ryn Deep	1 16 3	1 15 0
Village Deep	7 0	6 0
West Rand Consolidated (10s.)	7 6	7 3
West Springs	18 0	18 0
Witwatersrand (Knight's)	7 6	7 6
Witwatersrand Deep	5 0	5 0
RHODESIA:		
Cam and Motor	1 7 6	1 6 3
Gaika	4 3	4 9
Globe and Phœnix (5s.)	10 0	10 3
Lonely Reef	1 1 3	1 0 0
Mayfair	1 0 0	1 0 0
Rezende	16 3	16 3
Shamva	6 3	5 6
Sherwood Sta[illegible]	17 9	1 5 0
GOLD COAST[illegible]		
Ashanti [illegible]	1 4 6	1 3 0
Taquah [illegible]osso (5s.)	2 0	2 0
AUSTR[illegible]:		
Gol[illegible]eshoe (4s.), W.A.	—	1 9
G[illegible]der Proprietary (2s.), W.A.	2 0	2 0
[illegible] and Star (4s.), W.A.	13 6	13 0
[illegible]walia, W.A.	2 3	2 0
[illegible]algurli (10s.), W.A.	14 3	13 9
[illegible] (5s.), N.Z.	13 0	13 0
[illegible]ia Gold, W.A.	1 3 6	1 0 6
[illegible]:		
[illegible]aghat (10s.)	5 0	5 0
[illegible]ampion Reef (10s).	9 9	9 6
[illegible]ysore (10s.)	12 0	12 0
[illegible]undydroog (10s.)	17 0	17 6
[illegible]oregum (10s.)	8 0	8 0
[illegible]MERICA:		
Camp Bird (2s.), Colorado	2 9	2 3
Exploration (10s.)	9 0	8 9
Frontino and Bolivia, Colombia	7 6	7 6
Mexican Corporation, Mexico	17 9	15 0
Mexico Mines of El Oro, Mexico	6 3	2 9
Panama Corporation	19 0	18 0
St. John del Rey, Brazil	15 9	17 0
Santa Gertrudis, Mexico	9 6	10 3
Selukwe (2s. 6d.), British Columbia	5 9	6 9
MISCELLANEOUS:		
Chosen, Korea	1 0 0	1 5 0
Edie (5s.), New Guinea	—	1 4 0
Lena Goldfields, Russia	3 6	3 0
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	1 14 9	1 8 3
Esperanza Copper, Spain	1 1 6	1 2 3
Indian (2s.)	2 6	2 6
Loangwa (5s.), Rhodesia	9 6	10 9
Luiri (5s.), Rhodesia	7 0	5 9
Messina (5s.), Transvaal	19 9	18 9
Mount Lyell, Tasmania	2 3 9	2 1 6
Namaqua (£2), Cape Province	18 9	17 6
N'Changa, Rhodesia	3 17 6	2 16 3
Rhodesia-Katanga	2 2 0	1 13 9
Rio Tinto (£5), Spain	53 0 0	53 7 6
Roan Antelope (5s.), Rhodesia	2 10 0	2 3 9
Tanganyika, Congo and Rhodesia	3 3 0	2 16 3
Tharsis (£2), Spain	5 12 6	6 1 3

LEAD-ZINC:	Sept. 9 1929. £ s. d.	October 9. 1929. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	15 0	14 6
Broken Hill Proprietary, N.S.W.	1 9 3	1 7 9
Broken Hill North, N.S.W.	5 17 6	5 15 0
Broken Hill South, N.S.W.	3 10 0	3 7 6
Burma Corporation (10 rupees)	18 0	17 9
Electrolytic Zinc Pref., Tasmania	1 17 6	1 15 0
Mount Isa, Queensland	2 0 0	1 15 0
Rhodesia Broken Hill (5s.)	4 3	4 0
San Francisco (10s.), Mexico	1 15 3	1 16 6
Sulphide Corporation (15s.), N.S.W.	1 1 3	19 6
ditto, Pref.	1 7 0	1 6 9
Zinc Corporation (10s.), N.S.W.	2 11 3	2 8 9
ditto, Pref.	4 15 0	4 13 9
TIN:		
Aramayo Mines (25 fr.), Bolivia	2 18 9	2 15 0
Associated Tin (5s.), Nigeria	9 0	6 9
Bangrin, Siam	1 15 0	1 11 3
Bisichi (10s.), Nigeria	8 9	8 3
Chenderiang, Malay	9 0	9 0
Consolidated Tin Mines of Burma	9 6	9 9
East Pool (5s.), Cornwall	1 6	1 3
Ex-Lands Nigeria (2s.), Nigeria	2 6	2 0
Geevor (10s.), Cornwall	7 3	7 0
Gopeng, Malaya	2 3 9	2 3 9
Idris (5s.), Malaya	13 6	11 6
Ipoh Dredging (16s.), Malay	1 7 3	1 4 0
Kaduna Prospectors (5s.), Nigeria	10 0	9 6
Kaduna Syndicate (5s.), Nigeria	17 6	15 0
Kamunting (5s.), Malay	14 6	13 3
Kepong, Malay	1 6 3	1 5 0
Kinta, Malay	12 6	12 0
Kinta Kellas, Malay	1 13 9	1 15 6
Kramat Pulai, Malay	1 8 6	1 5 6
Lahat, Malay	13 6	13 6
Malayan Tin Dredging (5s.)	1 7 6	1 5 3
Mongu (10s.), Nigeria	8 0	7 0
Naraguta, Nigeria	18 9	15 0
Nigerian Base Metals (5s.)	3 6	2 6
N.N. Bauchi, Nigeria (10s.), Ord.	1 4 0	17 6
ditto (10s.), Pref.	1 8 9	18 9
Pahang Consolidated (5s.), Malay	10 3	9 3
Penawat ($1), Malay	2 6	2 3
Pengkalen (5s.), Malay	1 0 0	19 6
Petaling (2s. 4d.), Malay	13 0	12 9
Rambutan, Malay	16 9	15 0
Renong Dredging, Malay	1 11 3	1 10 6
Siamese Tin (5s.), Siam	14 3	13 6
South Crofty (5s.), Cornwall	4 0	3 6
Southern Malayan	17 3	15 3
Southern Perak, Malay	2 15 0	2 8 9
Southern Tronoh (5s.), Malay	12 0	10 6
Sungei Besi (5s.), Malay	14 6	13 3
Sungei Kinta, Malay	1 1 0	1 1 0
Tanjong (5s.), Malay	15 9	14 6
Tavoy (4s.), Burma	10 9	8 6
Tekka, Malay	1 1 6	1 1 6
Tekka Taiping, Malay	1 4 0	1 2 6
Temengor, Malay	1 14 6	1 11 3
Toyo (10s.), Japan	10 6	8 6
Tronoh (5s.), Malay	1 0 9	19 6
DIAMONDS:		
Consol. African Selection Trust (5s.)	1 8 9	1 8 0
Consolidated of S.W.A.	1 5 3	1 4 6
De Beers Deferred (£2 10s.)	12 8 9	11 12 6
Jagersfontein	2 10 0	2 5 6
Premier Preferred (5s.)	5 15 0	5 12 6
FINANCE, ETC.:		
Anglo-American Corporation	2 3 9	1 15 0
Anglo-French Exploration	1 2 0	1 2 6
Anglo-Continental (10s.)	10 0	8 3
Anglo-Oriental (Ord., 5s.)	10 0	7 0
ditto, Pref.	19 0	15 0
British South Africa (15s.)	2 2 9	2 0 0
Central Mining (£8)	18 15 0	17 10 0
Consolidated Gold Fields	2 17 6	2 11 3
Consolidated Mines Selection (10s.)	18 9	19 3
Fanti Consols (8s.)	14 9	13 9
General Mining and Finance	1 0 0	18 9
Gold Fields Rhodesian (10s.)	11 6	9 9
Johannesburg Consolidated	2 9 6	2 4 9
London Malayan	17 3	13 0
London Tin Syndicate	3 0 6	2 1 3
Minerals Separation	6 10 0	5 10 0
National Mining (8s.)	3 6	3 0
Rand Mines (5s.)	3 2 0	2 18 9
Rand Selection (5s.)	17 6	16 9
Rhodesian Anglo-American (10s.)	2 9 6	2 1 3
Rhodesian Congo Border	10 5 0	9 1 3
Rhodesian Selection Trust (5s.)	4 2 6	3 15 0
South African Gold Trust	1 10 0	1 8 9
Southern Rhodesia Base Metals	1 5 0	17 6
Tigon (5s.)	1 7 6	1 7 6
Tin Selection Trust	1 4 6	19 9
Union Corporation (12s. 6d.)	4 3 9	3 17 6
Venture Trust (10s.)	8 3	6 6

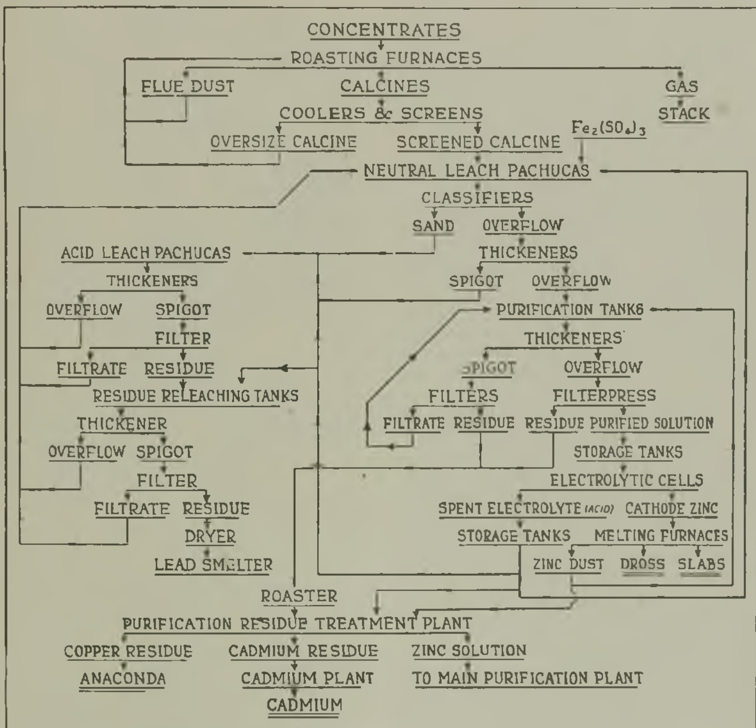
THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

ELECTROLYTIC ZINC AT ANACONDA

The *Engineering and Mining Journal* for August 24 is devoted to a series of articles on the various mining and metallurgical operations of the Anaconda Copper Mining Co. Among these articles is one on "Electrolytic Zinc Practice at Great Falls and Anaconda" by A. E. Wiggin and R. B. Caples. The first of these installations was that at Great Falls, and this was described in 1921 in a paper read before the American Institute of Mining and Metallurgical Engineers. Since then the daily output of zinc has been increased to 350 tons. The plant at Anaconda was put into commission in 1928 with a daily capacity of 175 tons. No fundamental change in the process has been made since the start of zinc production but improvements have been steadily introduced, notably when the company began to buy custom concentrates. The adaptability of the process, which employs low acid strength and low current density, is amply proved by the gradual change in the material treated and the widening of the sources from which the material is drawn. The original Great Falls plant was built primarily to treat Anaconda company zinc ores from the Butte district, custom ore business being considered a minor matter. Development of selective flotation completely changed the position by making available large tonnages of high-grade zinc concentrate in Utah, Colorado, and Idaho, in addition to lengthening the life of the Montana mines, and has kept the increasing plant capacity largely filled with custom zinc concentrate. The combination of selective flotation and a good market for zinc concentrate has greatly stimulated development of complex ores in Colorado, Utah, Montana, and Idaho. The present supply of zinc for the Anaconda company plants originates as follows: 50% in Montana, 33% in Colorado and Utah, and 17% in Idaho and from miscellaneous sources.



FLOW SHEET AT THE GREAT FALLS PLANT.

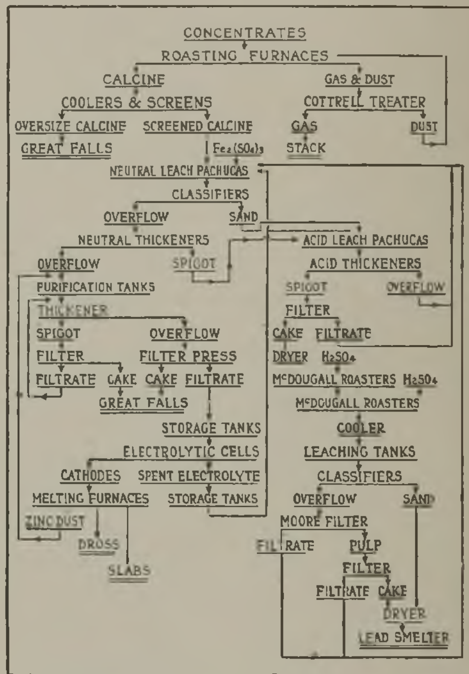
Each plant has fourteen 25 ft. shell diameter, seven-hearth, Anaconda-Wedge roasting furnaces. All of the Great Falls furnaces, and whatever additional furnaces at Anaconda are needed, are operated to supply the Great Falls plant. As all of the Anaconda furnace calcine goes through the same cooling and screening plant, the product is a composite of the production of all furnaces, and a portion of this product is shipped to Great Falls. The Anaconda furnace gases pass through a Cottrell treater for dust recovery. Great Falls furnace gases pass through the dust chamber built for the old copper-plant operations, where gas velocity is reduced to a point that allows most of the dust to settle ; from this the settled dust is drawn through hoppers into cars for return to the roasting furnaces. After leaving the dust chamber, the gases pass through a long flue leading to the stack, where some additional dust settlement takes place. The dust recovery at Great Falls compares very favourably with recovery at Anaconda. Total flue dust re-treated, including circulating load, averages a little over 15% of the weight of new material treated. From 35 to 40 tons of new feed, in addition to flue dust and calcine barrings, is roasted per furnace-day, producing calcine containing 0·2% sulphur as sulphides. The calcine is cooled in rotary coolers having trommel screens fastened on the discharge end. All calcine fed to the leaching plant passes an $\frac{1}{8}$ in. mesh screen. Oversize from this screen and undersize of a $\frac{3}{8}$ in. screen is crushed through rolls and returned to coolers to be re-screened. Oversize of the $\frac{3}{8}$ in. screen is crushed and returned to the roasters on account of its high sulphide sulphur content.

Anaconda furnaces are oil-fired and Great Falls furnaces are fired with natural gas. In each instance, two burners, spaced 180° apart, are fired directly on to the seventh hearth, eliminating the use of fireboxes. When coal was used, either lump or pulverized, outside fireboxes were used. When firing with pulverized coal of 9,500 B.t.u. heat value, approximately one ton of coal was required for seven tons of new feed, whereas approximately 14 gallons of oil, with 18,500 B.t.u. heat value and specific gravity 0·92, is used per ton of new feed. With natural gas, having a heat value of 930 B.t.u. net, approximately 2,400 cu. ft. is required per ton of new feed. Maximum temperatures of about 750° C. are obtained on the third and fourth roasting hearths. Calcine is discharged at about 500° C., and gases leave the furnace at about 525° C. The volume of gas per furnace at the uptake varies from 5,500 to 6,000 cu. ft. per minute at 0° C. and 760 mm. mercury, and contains 3% sulphur dioxide by volume. The furnace arms are water-cooled, requiring approximately 140,000 gallons of water per furnace per day.

In the roasting of concentrate containing 5% iron or less, practically all of the iron combines with zinc as $ZnO.Fe_2O_3$, which is nearly insoluble in dilute sulphuric acid. As the iron content increases above 5%, the combination of zinc and iron oxides can be partly controlled by careful regulation of temperatures on the various hearths. The total sulphur content of the calcine produced is regulated by the acid requirements of the plant, sulphide sulphur content being kept at all times at 0·2% or less. Acid losses are small, being chiefly as lead sulphate, basic iron sulphate, and entrained zinc sulphate in the residues discarded from the plant.

Actual leaching operations are divided into three steps : (1), Neutral, or purification, leach ; (2), acid, or finishing, leach ; and (3), re-treatment of residue from (2). The first two leaching steps are continuous leaching operations carried on in unlined Pachuca tanks using 30 lb. compressed air for agitation. Residue leaching is a batch leach operation conducted in unlined, mechanically agitated wooden tanks. No lead-lined tanks are used for leaching and no outside heat is supplied for leaching in the first and second steps. Solution going into the residue re-leaching operation at Great Falls is heated before adding the residue. Elevators equipped with bronze buckets are used for elevating pulp.

As less than 5% of the iron contained in the calcine is soluble in the acid strength employed in the first and second leaching steps, scrap iron is dissolved in spent electrolyte and the resulting ferrous sulphate solution is oxidized to ferric sulphate by



Flow Sheet of the Anaconda Electrolytic Zinc Plant.

manganese dioxide and is added to the first, or neutral, leach step, as required for purification of solution for arsenic and antimony.

To the neutral leach is added all of the calcine, but only a part of the acid (spent electrolyte), resulting in the presence of an excess of zinc oxide for precipitation of such impurities as iron, silica, alumina, arsenic, and antimony. The leaching solution is a mixture of spent electrolyte, acid thickener overflow, and returned solution from re-leaching of the residue, to which is added sufficient ferric sulphate solution to precipitate arsenic and antimony. The pulp from this leach goes to classifiers and thickeners, the thickener overflow going to purification tanks and the spigot product to the second, or acid leach. Classifier sand goes to the acid leach tanks.

Spent electrolyte is added to the second, or acid, leach in sufficient quantity to dissolve all uncombined zinc oxide in the residue from the first, or neutral, leach and to ensure an excess of acid in the leach discharge, excess acid being provided to ensure complete solution of free zinc oxide. The discharge from this leach goes to acid thickeners, the overflow being returned to the first or neutral leach and the spigot product delivered to filters.

At Great Falls, the undried filter cake is sent to mechanically agitated leaching tanks, previously filled with hot, spent electrolyte. As the leach progresses, part of the zinc-iron compound is decomposed, giving a solution rich in ferric sulphate and lowered in free acid. A further reaction between the ferric sulphate solution and zinc ferrite results in solution of the zinc oxide and precipitation of the iron as basic sulphate. This leach is discharged, while still acid, to thickeners, the overflow going to the first, or neutral, leach and the spigot to a Moore filter, where the residue is washed nearly free of entrained zinc sulphate solution. The pulp resulting from Moore filter operations goes to Oliver filters for dewatering and the Oliver cake goes to driers for partial drying before shipping to a lead smelter for recovery of lead, silver, gold, and copper. Residue from the final filters contains from 35 to 40% moisture and is dried to about 15% before shipment to the lead smelter. For this drying operation, a direct-fired, rotary drier, 9 by 60 ft., brick lined, is used. Dried residue is discharged from the drier to a drag conveyor, which discharges into railroad cars.

At Anaconda, residue from the second, or acid, leach is filtered on Oliver filters and is dried in a 9 by 60 ft. rotary direct-fired drier to about 10% moisture. This partly dried residue is mixed with concentrated sulphuric acid in a pug mill, and the resulting mud is fed into an oil-fired McDougal roasting furnace. The calcine from this operation is treated with an additional quantity of concentrated acid and is put through a second McDougal furnace, with a finishing temperature below the decomposition temperature of zinc sulphate. Acid addition and roasting are carried out in two steps on account of the impossibility of adding all of the acid at once without producing a pulp too thin to handle satisfactorily. The amount of acid added is regulated by the zinc content of the residue treated and the finishing temperature of the second roast is regulated by the amount of soluble iron desirable to produce in the finished calcine. This calcine is returned to the leaching plant and agitated with water to extract the soluble zinc, iron, and copper sulphates, the resulting pulp being sent to a thickener. Thickener overflow goes into the main solution system for purification, and the thickener spigot product goes to a Moore filter for washing; the Moore filter pulp goes to an Oliver filter for dewatering. The Oliver cake goes to a drier, and the dried product is shipped to a lead smelter.

Each method of residue re-treatment, that at Anaconda and that at Great Falls, decomposes a part of the zinc-iron compound formed in roasting zinc concentrate, and each method is probably the best under the set of conditions existing at that plant. The Anaconda method requires cheap sulphuric acid, obtainable at Anaconda, because an amount of acid equal to that used in residue re-treatment and returned to the leaching plant must be discarded from the process to avoid building up the zinc content of solution.

(*To be concluded.*)

PROGRESS IN ZINC METALLURGY

In the Mineral Industry for 1928 (Vol. 37) W. R. Ingalls reviews the progress in the metallurgy of zinc during that year.

The programme for plant modernization in America that was formulated in 1927 under the constraint of increasing delivery of flotation concentrate was vigorously carried out in 1928, which became therefore a year of demolition and reconstruction. The programme has comprised improved means for drying, the substitution of roasting furnaces of the McDougal and the Ingalls-McDougal type for the old Hegelers, sintering by Dwight-Lloyd machines, and the introduction of Cottrells and other means for dust collecting. By furnaces of the Ingalls-McDougal type is meant those that follow the general lines of the Ingalls patent of 1904, in which the stirring mechanism of the McDougal furnace is completely cooled by a current of air forced through it, the emerging hot air being then conveyed back to the cooler part of the furnace, effecting a transfer of heat from the part of the furnace where there is an excess to the part where there is a deficiency, the stirring mechanism being simultaneously protected. With this radical change in blende-roasting practice, the distilling furnaces and practice remain unaltered, but the use of sintered ore has had a profound and beneficial effect upon their operation and results.

Such a programme of modernization has been carried out in varying degrees at Bartlesville, Donora, Rose Lake, and Langeloth, the revision at the last plant being perhaps the most elaborate. Other plants that are now being improved are La Salle and Rosita (Mexico). Several other plants, both in the natural-gas fields and in the coal fields have added sintering machines, without going any further. These modernizations have involved expenditures running up to $1,000,000 per plant. In the aggregate the American zinc industry has probably incurred, or committed itself to, an expenditure of four or five million dollars in these ways. The effect of this has been to produce a sharp distinction between the distillers who are able to handle flotation concentrates and those who are not. This great improvement in the American zinc smelting industry was advisable under former conditions, but it became unavoidable with the increasing supply of flotation concentrate. Even during the last year the concentrate became finer and finer, it being the tendency in the mills to grind more and more in order better to liberate the component minerals. This improves both percentage of extraction and grade of concentrate. In respect of the blende concentrate the de-leading is being continuously improved. This is as it should be, for lead is treated more economically by the lead smelter directly than via the zinc distiller. However, this imposes other burdens upon the zinc smelter. To him is now delivered ore that goes wholly through a 200-mesh screen. It comes to him as a mud, frozen in winter, which upon drying becomes a flour that he has to keep from blowing away and also keep out of the lungs of his personnel.

In Europe, where the new metallurgical problems have been similar, although perhaps less acute, there have also been programmes for improvement, the most important of which have been the modernization of Uethemann by Giesche in Polish Silesia and the entire reconstruction of Flône by Vieille Montagne in Belgium. Uethemann has been reframed, up to the distilling department, on American lines; but in general European conditions do not sanction the extremely large roasting furnaces that are being built in America. The Langeloth furnaces, with their 12 hearths of 20 ft. diameter, are probably the largest mechanical blende-roasting furnaces operating in the zinc industry. The Herreshoff furnaces at Rose Lake have the same number of hearths and of the same diameter as those at Langeloth, but the furnaces of the latter plant are bulkier in their construction. All of these furnaces will be surpassed in size, however, by the 16-hearth Herreshoffs that are to be built at Donora.

In principle, American and European thoughts are quite the same. Both contemplate preroasting followed by sintering. America adopts the straight-line Dwight-Lloyd, whereas Europe divides between the straight-line and annular. Its straight-line machines, however, are designed with improved seals between pallets and wind box, which is a meritorious improvement that will no doubt be followed in America in future constructions. Europe and America employ both the Rigg and Baelen processes. For dust collection Cottrells are in general use, but Langeloth is dispensing with the Cottrell, temporarily at least, and relying upon an improved Sirocco form of cyclone, which is a distinct novelty in blende-roasting practice. The Sirocco delivers its dust collection directly back to the roasting furnace. From the latter the calcines go by closed conveyors to coolers, and thence to the bins of the sintering department.

At Langeloth there is another novelty. The ore is being dried on top of the roaster, where there are stirring arms and rabbles similar to those in the roasting chambers. The ore is primarily reduced to about 5% moisture in rotary dryers, at which point there is not much, if any, loss by dusting. This is necessary in order to be able to handle the ore by conveyors and otherwise, it becoming then no longer a mere mud. Delivered at the centre of the top of the roaster, the drying is there finished perfectly, the dried ore being spilled into a gutter surrounding the furnace from which it is charged mechanically into the furnace.

It is not at all certain that metallurgists know even yet how to operate the sintering process most advantageously. American practice is generally adopting the Baelen process, for Americans are not so far venturing to try to use the sintering gas. Probably they would be unable to do so unless alterations were made in the sintering machines. Bartlesville uses the Rigg process but wastes the gas, which Eastern smelters either are unable to do or do not want to. Blackwell uses the Baelen process and wastes all of its gas, both from roasters and sinterers. So far as can be seen from the examination of many figures, just as good desulphurization is done by one method as by the other. It looks as if the Baelen process were somewhat faster, but this is not certain. Of course the Baelen process requires the addition of fuel, the required quantity varying according to whether the sulphur to be eliminated exists mainly as sulphide or sulphate. Anyhow the sintering process appears to be delicate and susceptible to numerous deviations from what is just right.

Overpelt has introduced the process of making macaroni (metaphorically) out of the roasted ore as a preliminary to sintering, the idea being to improve the suction through fine ore and avoid dust loss. Such a process of making up the ore was once tried experimentally in at least two works in America, as a preliminary to roasting, but was rejected as being too costly. In the sintering process itself no difficulty is found in getting an even and adequate suction through a bed of preroasted flotation concentrate, and the loss of fine dust in that operation is slight. The dusting occurs before and after the sintering machine itself. It may be added also that there is no evidence of any major loss of zinc by reduction and volatilization, not even with the Baelen process, although probably there is a little, perhaps of the order of 0·5%. There is, however, a certain mechanical loss of ore in the handling of it to and from the sintering machine, which may amount from 0·5 to 1%.

Distilling furnaces remain unchanged. New Jersey Zinc Co. finally abandoned the Convers and Desaulles and substituted the Neureuther-Siemens but with only 240 retorts instead of 800 as at Depue, Peru, and Rose Lake. In Europe also the counter-current recuperative furnaces are passing out of use. Flône is being rebuilt with Dor furnaces, which many Belgian metallurgists consider to be the best, but in other plants there has been a noteworthy extension in the use of the Tanier furnace. The Giesche metallurgists, however, adopted the Welzel as their standard.

In respect to details of distillation, much attention was given to the subject of retorts and in America there was extensive experimentation with retorts in which carborundum replaces the grog, and with siliceous retorts in which a part of the grog is replaced by silica flour. The carborundum retorts are of materially higher thermal conductivity than the ordinary clay retort. It is also of superior chemical resistance in respect to ore of siliceous character. It is doubtful, however, whether these advantages are sufficient to offset the increased cost. With irony ore, however, the carborundum retorts do not always stand up well, and with producer-gas firing they are subject to serious external corrosion. The same defect has been observed in carborundum brick for lining fire boxes in steam boiler practice, etc. However, Amarillo (natural gas-firing) has had good results in distilling a sintered, irony ore in carborundum retorts. The silica-flour retorts are much less expensive than the carborundum. In some works, treating certain ores, they have given satisfactory results, In other works, treating irony ore, they have exhibited no superiority over the ordinary clay retort Some distillers are convinced of their merit; others continue to be doubtful.

It becomes more and more difficult to get good furnace chargers and this consequently directs attention toward mechanical charging. Even if this does not effect any economy it may be necessary as a substitute for human shortage. Palmerton has been doing mechanical charging for several years. Rose Lake does it in connection with two of its furnaces. In Belgium this has been done for a long time at Rothem. All of these mechanical chargers are forms that throw the charge into the retort, and the density of charging is a function of the force of the throw. There is such a thing, however, as charging too densely.

The troubles in distillation would be largely removed if it were possible to use vertical, continuously-operating retorts. The most extensive development in that direction heretofore has been in the Roitzheim-Remy furnace. A plant equipped with five of these furnaces is operated regularly at Berlin, galvanizers' ashes and skimmings being the material distilled. Waelz fume, or similar fume, might also be amenable. For ore distillation, however, the Roitzheim-Remy furnace has not proved itself. Such an application was tried at Bensberg. During 1928, a Roitzheim-Remy furnace was erected and put in operation at Avonmouth, and later abandoned.

In the subject of zinc distillation in vertical retorts, continuously operated, the overshadowing event is the development of the revolutionary Singmaster, Breyer, and Bunce furnace and process by New Jersey Zinc Co., at Palmerton. After prolonged trial of what was already a large furnace, a regular commercial unit has been built there and is almost ready to be placed in operation. Another unit is to be built this year at Depue. Columnar retorts of carborundum brick of great height and relatively large diameter, built up like a chimney and the use of a charge in the form of briquettes, or eggettes, are the elemental features. The eggettes have to be semi-coked.

In 1928 there was further application of the Waelz process. The largest and most important installation is that of Giesche Spólka Akcynja in Polish Silesia, which is to beneficiate the low-grade calamine of Blei-Scharley mine, the fume product going to Bernhardihuette for electrolytic extraction. This plant comprises five units of an estimated aggregate capacity of 800 tons per 24 hours. In this plant the fume is collected by baghouse filtration. Another important European installation was one for extraction of zinc from the Meggen pyrite, the treatment of which has long been a baffling metallurgical problem. The Meggen pyrite occurs in a large deposit, estimated at 14,000,000 tons, containing something like 9% zinc. It is reported that the Waelz plant dealing with this material is operating satisfactorily. In the United States the only Waelz plant so far is at Donora, working on retort residues. The fume-laden gases are caused to pass through a waste-heat boiler and having been cooled thereby the fume is precipitated by a Cottrell. About 1,000 tons of fume is being produced there monthly, and the Cottrell precipitation is pronounced highly efficient.

It may be feasible to put some of the between-products of the ordinary distilling furnaces, such as the "sample," floor cleanings, old condensers, etc., through the Waelz furnace rather than to return them directly to the distilling furnace. The quantity of such between-products alone would hardly be sufficient for a Waelz unit, but in connection with working up old residues it might be done. The Waelz fume is not an entirely acceptable material for the ordinary method of distillation, although the similar fume from the Pape process is, and for a long time has been, distilled at Hamburg. Any large production of such fume, however, will probably go to the electrolytic plant or the lithopone manufacturer or may possibly be briquetted and distilled in vertical retorts.

THE SHERRITT GORDON COPPER-ZINC DEPOSIT, NORTHERN MANITOBA

A paper on this important property which was presented before the Society of Economic Geologists at the New York meeting in December, 1928, by E. L. Bruce, is published in the August issue of *Economic Geology*. Full extracts from this paper are given here.

The mine is situated in the northern part of Manitoba, approximately 50 miles north-east of the Flin Flon ore-body. Its discovery came as a result of the impetus given to prospecting by the solving of the metallurgical problems at Flin Flon, and the decision to proceed with its active development. Flin Flon has been known since 1915 and the Mandy property four miles from it produced high-grade copper ore between 1916 and 1920. As a result the Indians who trapped in the country to the north were familiar with the appearance of sulphide gossan, and, with the renewal of interest in mineral deposits in northern Manitoba, prospectors soon began to make use of the knowledge of Indians and of white trappers. The result was the location of the Sherritt Gordon vein, a short distance east of Kississing Lake.

General Geology.—The geology of the area surrounding Kississing Lake differs from that in the vicinity of Flin Flon. The Mandy and Flin Flon ore-bodies occur in basic volcanic rocks to which the name, Amisk series, has been given. Lithologically they are similar to the Keewatin rocks of the Lake of the Woods district. They are Precambrian in age and are the oldest rocks recognized in the region. At the Sherritt Gordon mine the rocks are well banded gneisses of various types. The contact between the greenstones of the volcanic group and the gneisses of the northern area is difficult to locate. Rocks which appear in the field as schists formed by the alteration of the lavas prove to be basic gneisses composed of quartz and actinolite. In the hand specimen the only difference that can be noticed is a silky lustre that seems to be typical of the dark rocks assigned to the gneisses, whereas the foliated rocks derived from the alteration of the lavas have the dull green of chlorite.

The gneisses are intruded by granitic rocks, which in places have a sill relationship, and *lit par lit* injection of the gneiss by granite has taken place. It is difficult to estimate just how great a part of the gneissic rocks may be igneous in character, since the extreme metamorphism that they have undergone has produced recrystallization so thorough that many of them are decidedly like igneous rocks in texture. Those, however, which consist of abundant quartz associated with a felspar near labradorite in composition are believed to have been rather calcareous sandstones. Most of the garnetiferous rocks are thought to be recrystallized sediments.

Structure of the Gneisses.—Along the southern margin of the typical gneisses the dip is fairly steep, varying along Kisseynew Lake from vertical to dips of 75° northward. In a few places the dip is actually southward. Farther north the dip flattens so that at places along the shores of Kississing Lake the bands are essentially flat. Locally there are dips to the southward. Variations in strike of the beds produce troughs pitching northwards. In a large way, the gneisses within the area seem to be the southern limb of a great syncline with an east-west axis lying somewhere to the northward. On this major structure are minor synclines and anticlines with east-west axes as well as cross folds, the axes of which pitch to the north. This complexity of structure is probably due to the intrusions of granite, which have disturbed the beds and destroyed the regularity of the simple structure produced by regional stresses. The minor folds depending upon the granite intrusions are important structural features economically, and will be discussed in greater detail later.

Age Relations.—The structure of the Kisseynew gneisses leaves no doubt that in this area at least the major part of them lies above the volcanics. It has been impossible, however, to find any definite break between the two series and the contact appears to be gradational. Rocks similar lithologically and probably continuous with the Kisseynew gneisses have been described by Alcock at Wekusko Lake under the name of the Wekusko series. He found garnetiferous, staurolitic, and kyanitic biotite-quartz gneisses interbedded with undoubtedly sedimentary quartzites which still retain the cross bedding of the original sands. Flows were found interbedded with the typical sedimentary gneisses.

So far as the age is concerned, it may be said that in the area under discussion, the sedimentary gneisses are younger than the volcanic rocks for the most part but there was no break between the formation of the two series and probably there was an interval of alternating volcanic and sedimentary deposition between the dominantly volcanic and the dominantly sedimentary periods.

Large bodies of granite of a normal character with typical coarse texture occur throughout the area. Marginally, and surrounding inclusions, there are lithological variations, but over great areas the rock is a fresh bright pink granite consisting of orthoclase and plagioclase, quartz, hornblende and biotite in varying proportions; magnetite, apatite and zircon occur in minor amounts; sericite and kaolin are present as alteration products.

In the part of the area immediately south of Kississing Lake are various tongues and some fairly large masses of a fine-grained red granite that is distinctive enough to be mapped separately. The fine texture and red colour are characteristic. Microscopically, this granite is found to contain orthoclase, microcline, quartz and biotite. The orthoclase shows some alteration but the rock is fairly fresh.

It is noteworthy that contacts of the fine-grained red granite with the gneisses are usually sharp. Ordinarily it has the structure of sills. In places it intrudes the gneisses *lit par lit* but there is practically no shatter zone, and it probably had little mineralizing effect.

The Structure of the Ore-body.—So far as is known at present the eastern part of the ore-body is lenticular, but the western is much more regular. The width of the regular western part varies from 8 to 10 ft. normal to the walls. Some of the eastern lenses have a much greater thickness. The strike of the vein is N.W. The dip varies; at the west end it is 30° N.E., flattening down the dip to a very low angle; easterly along the vein, the dip steepens and at the east shaft it is steep to the south-west. North-east of Shellet Lake the dip of the gneisses is to the south and there is probably a syncline in the sediments to the north-east of the western part of the vein. If so, there is the possibility that it will outcrop again to the northward, but it is more likely that the anticline to the north of the small syncline has not been eroded deeply enough to expose it. At most places the vein is conformable to the gneisses but there seem to be some offshoots of it which cross the structure. It was formerly thought that the ore lay between a hanging wall of basic gneiss and a foot-wall of acid gneiss. The relation is not so simple. Either type of gneiss may be foot-wall or hanging wall.

Mineralogy.—The Sherritt Gordon ore is fairly coarse-grained. The metallic minerals present in it are pyrrhotite, chalcopyrite or chalmersite, sphalerite, and marcasite. The non-metallic minerals recognized are quartz, amphibole, possibly actinolite, chlorite, garnet, biotite and scapolite.

Pyrrhotite is by far the most abundant metallic mineral. The only noteworthy feature in it is the size of grain. Parting is well developed and some grains have much the appearance of a book of mica of account of this characteristic. The sphalerite and chalcopyrite are considerably less in quantity than the pyrrhotite. The average content of much of the ore is approximately 3% each of copper and zinc. The newer developments to the north-west and parts of the large lens at the 125 ft. level of the east shaft carry somewhat greater quantities. The sphalerite is a purplish black variety and is of medium grain. Marcasite is present in the upper parts of the deposit but it is stated that none has been found far below the surface. Polished sections show a striking concentric structure. Of the metallic minerals, pyrrhotite is evidently the oldest as it shows replacement by the chalcopyrite and sphalerite. The sphalerite and chalcopyrite have a graphic structure, and it is impossible, so far as has yet been observed, to determine whether they are contemporaneous or of different periods. The marcasite is clearly later and probably represents reprecipitation of iron solutions just below the zone of weathering.

Quartz occurs quite abundantly in the ore. Most of it is in the form of rounded particles which, however, have rough surfaces as if they had been etched. None of them show crystal forms. Actinolite, in cigar-shaped forms, is present, and in places there is biotite. All of these are older than the sulphides and apparently were original constituents of the gneiss, the composition of which determined whether the ore should contain actinolite or biotite. One well formed crystal of a dark grey scapolite was observed embedded in pyrrhotite. Chlorite is abundant along some of the ore margins.

A suite of specimens from a drill core which intersected the ore at a considerable depth below the surface shows the ore relations very clearly. In the hand specimen, the solid sulphides, which are chiefly pyrrhotite with some sphalerite, are separated from the gneiss by a zone from ⅛ to ¼ of an inch thick of a dull greenish mineral. A fracture extends outward from the edge of this zone into the gneiss and this also is filled with the greenish mineral. A thin section of the green zone shows quartz which has been fractured and the fractures filled with chlorite. Other areas which were apparently originally quartz are now so completely replaced that they have a mossy appearance. Foils of chlorite are abundant. The sulphides replace the chlorite. A thin section taken an inch from the border zone contains abundant quartz and biotite with some felspar, both orthoclase and plagioclase. These have the closely interlocking mosaic texture of metamorphosed sediments. The biotite in places shows parts of a crystal chloritized. Veinlets of chlorite intersect the quartz and felspar, and in places there is evident the beginning of replacement of those minerals by chlorite. Pyrrhotite grains are abundant. Some of them replace biotite with no marginal zone, but many of them are separated from the older minerals by a rim of chlorite. Some of these rims show a decided zonal structure. Other sections of ore show a zone of light green to nearly colourless chlorite between the sulphides and the minerals of the gneiss. The colour is paler as the distance from the sulphide grains increases.

Genesis of the Ore.—Any theory of origin of the deposit must explain its formation parallel to the bedding, the peculiar reversal in dip, that is, the warped plane of the deposit, the reason for the location in this area of heterogeneous acid and basic gneisses whereas other areas are barren, the presence of the large amount of quartz in the vein, the presence of garnet and scapolite, and the order observed in the deposition of the minerals. The general structure of the gneisses is that of a great syncline the southern limb of which dips away from the volcanics to the south. Along the main body of Kississing Lake the beds are at very low angles and there are many domes or minor anticlines and synclines that have their axes nearly transverse to that of the main fold. Along the east side of Kississing Lake, between that lake and the Sherritt Gordon, the strike of the gneiss is N.W. and the dip to the N.E. As mentioned above, a minor syncline lies immediately north of the mine. That is, the deposit lies on one limb of this minor fold.

The localization of the opening is probably due to the heterogeneity of the beds. It is well recognized that, where there is a marked difference in the competence of beds, folding will tend to cause movements parallel to the bedding and a resultant opening up of spaces along the axes of minor folds. The mechanism of the minor cross folds is not clear but it is possible that they are related to unexposed granite masses. An intrusion of greater size than ordinary with a thrust to the north may explain the reversal of the dip and the warping of the plane of the ore-body, which is its most puzzling feature. It is suggested, therefore, that the opening or the weakness now occupied by the vein was formed because of the folding, the effects of which were especially great at this point on account of differences in the competency of the acid and basic gneisses. The cross folds may be the result of granite intrusions as yet unexposed and these are assumed also to explain the warped plane of the vein.

The rounded blebs of quartz distributed abundantly in the ore are probably not original crystals since it is unlikely that they crystallized from a solution which formed the sulphides. If there were an original quartzose zone largely replaced by sulphides the quartz would not be so evenly distributed as granules in the sulphides but would appear as more or less thoroughly replaced areas. If it be assumed that the quartz represents original quartz in a bed of sedimentary gneiss now largely replaced by sulphides, the arrangement, shape and etched character of the blebs is explained. The chlorite, mentioned above as a marginal facies of the ore zone, is evidently a product of the first stage of mineral deposition acting upon the enclosing rock. Original biotite was altered to chlorite, and the excess ferrous iron in the pyrrhotite mixture, uniting with the excess silica of the gneiss, formed the chlorite in the quartz grains and in the chlorite-filled veinlets. The scapolite and perhaps some of the garnet enclosed in sulphides are further evidence of reaction between ore solutions and wall rock. All of the evidence points to contact-metamorphic reactions between ore-bearing solutions high in iron upon the original minerals of a bed of gneiss along which had been localized shearing movements, due to disturbances perhaps the result of the invasion of the granite batholiths. These movements must have been most intense near upward-projecting masses of granite, and around these masses also ore solutions concentrated. There is thus a genetic relationship both structural and chemical between the granite and the ore-bodies. Evidently the ore must have been the result of the last stages of the granite cooling, since it occurs cutting the pegmatites which themselves are the products of a late cooling stage.

Weathering.—Ordinarily, continental glaciation has removed the weathered material from rock surfaces in this region and the amount of weathering since glacial times has been insufficient to produce much gossan above the sulphide bodies. Locally, however, the geological structure has been such that weathered material, formed in the glacial times, has been preserved. It seems likely that the thick bed of rusty clays at Flin Flon has been protected from removal by the ridge of resistant greenstone to the north-east. Similarly, wherever the gneisses have a strike transverse to the glacial movement and especially where the dips are low to the north, any weathered products formed in any individual bed may be protected by an unweathered overlying stratum. At several places along the Sherritt Gordon vein, a considerable quantity of iron-stained material is found above the vein although in other places, notably where the vein comes to the lake at the original discovery pit, the unweathered sulphides are fairly close to the surface.

Along the extension of the vein beyond the west shaft sink-holes occur with ten to fifteen feet of the upper part of the vein completely removed and part of the space filled with till. Below the till is iron-stained material from which the sulphides have been weathered. At several places the weathering-out of the vein has allowed the hanging wall bed to cave in and completely mask the underlying sulphides and gossan, giving the impression in the trenches that the vein does not occur in that part of the zone. In one place at least the persistence of the vein was demonstrated only by diamond-drilling beneath the apparently barren surface.

Cyaniding Copper-Bearing Gold Ores.—In *Technical Publication* No. 250 of the American Institute of Mining and Metallurgical Engineers E. S. Leaver and J. A. Woolf, of the Rare and Precious Metals Experiment Station, Reno, Nevada, describe laboratory experiments undertaken with a view to finding a method of cyaniding gold and silver ores that carry copper. As is well known a copper content consumes so much cyanide as to make the cyanide process inapplicable to copper-bearing ores. The author's process is applicable to ores containing less than 0·5 % copper and it consists in maintaining free cyanide in the solution by regenerating the cyanide from the copper-sodium cyanide, this being done by precipitating the copper by the combined action of sulphide of soda and sulphuric acid.

The authors first tested the relative solubilities of various copper minerals in cyanide. They found that azurite, bornite, chalcocite, cuprite, malachite, and finely divided metallic copper are readily and completely soluble under the usual conditions for cyanidation. Enargite and tetrahedrite are sufficiently soluble to cause an excessive loss of cyanide, and they also cause fouling of solutions with arsenic and antimony. Precious-metal ores containing small percentages of chalcopyrite or chrysocolla may give satisfactory returns with the usual cyanidation.

The chemical reactions involved in the cyanide dissolution of copper from copper minerals are complex and vary with the different minerals. From the plant standpoint the important consideration is the amount of the active cyanide solvent that is used in the mill solution for the dissolution of copper. The ratio of cyanide used to copper dissolved was found to vary for each of the minerals tested. It corresponds approximately to an average molecular ratio of 3 to 1. The higher loss for enargite is in part due to dissolution of arsenic. The loss for tetrahedrite is also higher than the average, due to dissolution of antimony. The low loss for cuprite and the lowest loss for metallic copper are probably explained by the reactions that do not include the formation of cyanates or the least amount of complex cyanide compounds.

Solutions containing different amounts of copper were prepared by dissolving malachite in sodium cyanide solution. This dissolution was carried on until only a little free cyanide remained, as indicated by titration with silver nitrate. Sodium cyanide salt was then added to the solution to increase the free cyanide content, after which the solutions were used to treat a gold-silver ore by agitation. It was found that the presence of copper in amounts up to 4 lb. per ton of solution has no detrimental effect on the extraction of gold and silver. Additional experiments indicated that the copper may be increased to 10 lb. per ton of solution without affecting its efficacy as a solvent for precious metals, provided that the solution contains free cyanide equal to the quantity needed in fresh solution to obtain maximum extraction.

Solutions were prepared by treating malachite with a sodium cyanide solution until no more copper would go into solution. Even at this point there invariably remained a small amount of free cyanide in the solution, as shown by titration with silver nitrate. These solutions containing varied amounts of sodium-copper cyanide were used in the treatment of a gold-silver ore known to yield good extraction with clean sodium cyanide solution. The sodium-copper cyanide solution formed by the dissolution of malachite in sodium cyanide is a weak solvent for the precious metals. The dissolving effect of this solution is roughly proportional to the time of contact. It was also noted that the pregnant copper cyanide solution generally shows a small amount of free cyanide, which indicates that the double cyanide is slightly dissociated. This dissociation closely follows the time of contact and the dissolution of the precious metals. Excess lime does not increase the extraction of precious metals but an excess of caustic soda greatly increases gold extraction, and to a lesser extent favourably affects silver extraction over a 24 hour period.

Although the presence of copper in cyanide solution, in amounts not exceeding 4 or 5 lb. per ton, does not appear to affect adversely the extraction of gold and silver when sufficient free cyanide is present, it is necessary that the copper be removed to prevent excessive accumulation. Also from the cost standpoint, the cyanide combined with the copper must be released for re-use in dissolving precious metals. Zinc will precipitate the copper almost completely after several hours agitation. The zinc replaces the copper, thus forming the double sodium-zinc cyanide, which in the presence of excess free alkali is a weak solvent for gold and silver. The accumulation of zinc in the solution from this precipitation, however, tends to lower the extraction of the precious metals, and if maximum extraction is to be maintained either the zinc must be removed from the solution or some other method of precipitating the copper must be employed. Magnesium dust was tried as a precipitant under varied conditions of time, temperature, alkalinity, and acidity, but the results were negative from the standpoint of plant application.

In the final experiments the desired quantities of copper in the solution were obtained by treating malachite with sodium cyanide solution containing free alkali in the form of lime at normal room temperature. The copper was then precipitated with sodium sulphide and sulphuric acid. The amount of cyanide regenerated was determined by titration with silver nitrate at various steps in the procedure. Sodium sulphide is not a precipitant for copper from an alkaline cyanide solution, but it is an effective precipitant if the solution is acidified. The hydrocyanic acid formed is very soluble at temperatures below 26° C., but some of it will readily escape from solutions in open containers, especially if the solution is subjected to agitation. It is necessary to make provision for retaining this gas until the precipitate has been removed and the solution made alkaline. The consumption of sodium sulphide is proportional to the amount of copper precipitated. In the experiments, where 98% or more of the copper was precipitated, the consumption of sodium sulphide averaged about 0·7 lb. (calculated on a basis of 100% Na_2S) per pound of copper precipitated. The acid consumption depends on the strength of the original solution in both cyanide and lime. In the tests recorded it varied from 4·5 to 6·5 lb. of sulphuric acid per pound of copper precipitated.

In ascertaining the dissolving efficiency of regenerated solutions, a fresh sodium cyanide solution titrating 4·9 lb. NaCN was prepared and used to dissolve copper from malachite until saturated. The resultant solution was used in the treatment of an ore under described conditions. The experiments showed that the regenerated solution was as active as a fresh cyanide solution in the dissolution of the precious metals. Several series of experiments were made with precious-metal ores containing soluble copper, in which the dissolved metals were precipitated and the solution regenerated at the end of each cycle; the regenerated solution was used in the following cycle. Enough sodium cyanide salt was added to the barren solution each time to keep the solution strength about constant. An average of a little more than 80% of the total cyanide used during the dissolving period was regenerated. These figures are substantiated by the fact that the amounts of cyanide added at the end of each cycle were calculated and checked by titrations. The extractions are nearly constant through the entire series, showing that the regenerated solution retains its efficacy as a solvent for copper and precious metals.

For ores containing a small amount of copper, say 0·1 to 0·2% the experiments showed that it is not necessary or even advisable to precipitate the metals from the solution after each cycle; every third or fourth cycle is often enough. The dissolved metals accumulate in solution but do not decrease the subsequent extraction of the precious metals. Complex ores that contain a fractional percentage of copper necessarily show higher acid consumption per pound of copper precipitated, because the ratio of lime and cyanide to copper in the solution is greater. In these experiments the average loss of acid is approximately 7 lb. per pound of copper precipitated. The consumption of sodium sulphide is proportional to the amount of metals to be precipitated. In these tests it approximates 0·9 lb. of sodium sulphide per pound of copper precipitated. The extraction of gold and silver remain nearly constant during the cyclic experiments for each ore. This shows that the regenerated solution is as effective a solvent as fresh solution.

High-Tension Cables Underground.—A paper describing the installation of high-tension electric cables underground at Crown Mines Shaft No. 14 was read before the South African Institute of Electrical Engineers by W. Elsdon Dew and H. Denehy in July, and the *South African Mining and Engineering Journal* of August 3 gives useful additional comments on the subject. Hitherto electric mine installations have been reduced to working voltage at surface and the current distributed underground at that voltage. In an extensive mine these underground distributing mains total up to an inconvenient size for the shaft accommodation, especially when it is remembered that with the intermittent loads in hoisting and hauling it is necessary to have currents much higher than for a regular load in order to provide for the peaks at starting. When double-stage winding was adopted at Shaft 14 the advantages of distribution at a higher voltage was once more considered. The obstacle standing in the way of high-tension currents underground has been the impossibility of providing a safe cable that will function in a vertical position owing to the semi-liquid nature of the insulation. Eventually the firm of W. T. Glover and Co., Ltd., undertook to manufacture a cable for Crown Mines in which the insulation is solid under ordinary temperatures, and the installation now carries current at 20,000 volts, which is the standard surface-distribution current in the Central Rand, this to be converted to 2,000 volts underground. The accompanying illustration (Fig. 1) gives an outline of the installation.

In describing the nature of the cable employed the authors say that the ordinary impregnated paper cable contains impregnating oils which are liquid and mobile at ordinary operating temperatures. When such cables are suspended vertically in a shaft, the hydrostatic pressure and mobility combine to cause distention of the cable sheath at the bottom of a length, and voids and vacua in the upper portions. Such a cable is therefore practically useless in a vertical or steeply inclined shaft. For the moderate pressure of 2,000 volts it was possible to use a "drained" cable, from which all mobile fluid had been removed, but the removal could only result in the voids

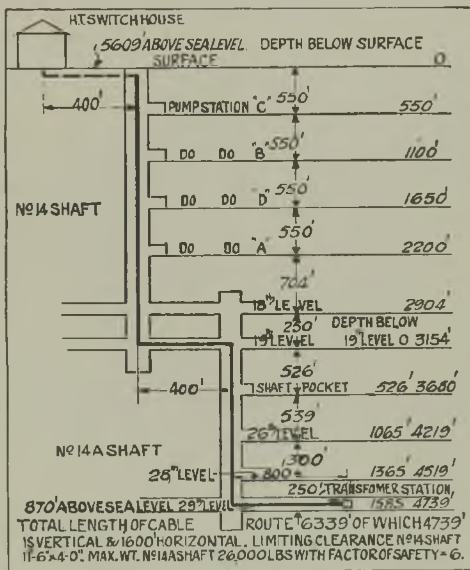


FIG. 1.

created being filled by air. Failure of a high-tension cable can usually be attributed to ionization in air pockets, however small, resulting in charring and destruction of the insulation. A drained cable was thus out of the question for 20,000 volts.

The stranded conductors are built up with a plastic compound, solid at working temperatures, filling all the interstices between the wires. The paper insulation is uniformly pre-impregnated with a compound again not liquid at ordinary temperatures, and the strips are applied to the conductors in a bath of the same compound. Shaped fillers of a solid but plastic compound are used to fill the centre and outer interstices formed when the three conductors are bunched into a 3-phase cable. These are applied under pressure, thus again expelling all air. Overall lappings of insulation and copper sheath and finally the enclosing lead sheath are all applied under a head of liquid impregnating material, and the final result is a three-core cable containing practically no drainable compound at the highest operating temperatures, but at the same time no air pockets whatsoever. (See Fig. 2.)

The largest single length of cable installed was 1,150 ft., and the drums carrying these lengths measured 11 ft. in diameter and weighed 11 tons. Each of the duplicate cables was in eleven lengths. The cable drums were supported in a skeleton cage for lowering and paying out in the shaft. Above the skeleton cage a working cage, running in the same compartment but on a separate winding rope, was kept 40 ft. above the cable drum. Clamping was done from a platform projecting from the upper cage, clamps being placed, in the vertical portion, at distances not exceeding 45 ft. In-bye lengths were supported from a catenary of discarded hauling rope by clamps spaced at not more than 4 ft. apart.

Jointing operations are of special interest. In a straight-through jointing box, the armouring is clamped to a gun-metal gland wiped to the lead, and electrical continuity of the lead is maintained

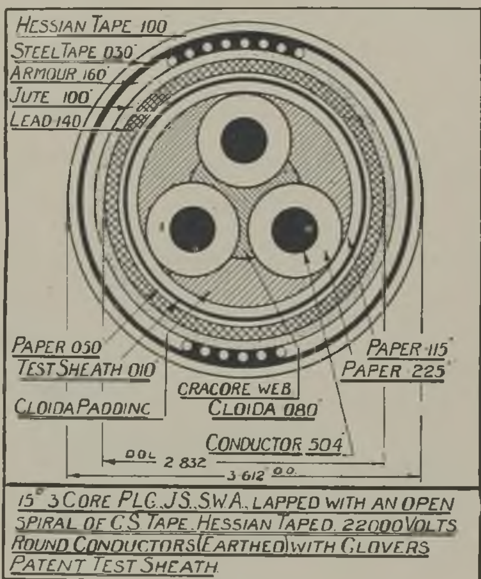


FIG. 2.

by means of a copper strip. The test strips are connected through by means of a wire cage connected to sheaths soldered to the copper strips. During jointing operations, which occupied from 10 to 12 hours per joint, temperatures and relative humidity figures were taken. The maximum figures obtained were at the first shaft pocket in No. 14a Shaft, namely, 110° F. and 89%. The average values for these figures were 80° F. and 82% relative humidity. When the joint is completed, prior to pouring, the joint box lid is bolted on and a desiccator applied. The desiccator consists of a petrol-engine-driven air pump which pumps air at a few pounds above atmospheric pressure through a series of four vessels containing a calcium chloride drier in trays, thence by a hose and connection to the sealed joint box, whence it exhausts to the atmosphere by a pet cock screwed into the box for the purpose. The period for desiccating was varied from half to one hour according to the humidity. As most of the joint boxes contain over 200 lb. of compound, and bearing in mind the extreme importance of avoiding, as far as possible, the occlusion of gases in the compound during filling operations, a special compound boiler (developed by Messrs. Glover) is used, equipped with a hand pump for circulating the compound during the heating period and later, by the manipulation of valves for the filling process, the compound being piped to the boxes. The compound is heated by a paraffin burner to about 10° F. higher than the pouring temperature of 320° F. The breakdown voltage of the compound is 55 k.v. for the B.E.S.A. oil testing gap, that is, 150 mils between ½ in. spheres.

For the in-bye joints it was necessary to retain the boiler in the cage and pipe the compound through piping as long as 24 ft. to the boxes, in which case it was necessary to heat the pipes with blow lamps before pouring. After the joint boxes had been sealed up and allowed to cool off for a period not less than seven days, they were opened up and topped; the shrinkage was found to vary between 1¾ in. to 3 in. In spite of these elaborate precautions, air holes showed up in one or two cases; these were carefully heated with blow lamps and melted compound allowed to fill in, after which they were topped.

The three-phase cables terminate in trifurcating boxes from which single-core lead-covered cables are taken to potheads sealed to the transformer tanks below oil level. Six 2,000 k.v.a. single-phase transformers are installed, and the whole of the connexions to these are completely enclosed, this being a rigid feature of the specification. In order to exclude mine air from the transformers, due to breathing, the authors state that Mr. Curtis, the mine electrical engineer, is fitting a flexible bag to the calcium chloride breathers. The station is protected by special fire doors controlled from an adjacent engine-room, so that in the remote contingency of fire, the equipment may be isolated from the mine air system.

Tin in Manitoba.—The *Canadian Mining Journal* for August 30 contains an article on tin prospects in Manitoba by J. S. Delury, of which full extracts are given here.

The greater part of south-eastern Manitoba is occupied by part of a huge batholith of granite. This has suffered so much erosion during past geological time that only near its edges are roof pendants and synclinal troughs of schistose rocks to be found, small remnants of a vast and thick surface formation into which the granite was injected. Portions of this batholith are exposed in the Lake of the Woods region of Ontario, where they are responsible for the gold mineralization. This is probably the Algoman granite of Ontario. West of Lake of the Woods, in Manitoba but close to the Ontario boundary, there are several troughs and roof pendants of volcanic and sedimentary schists lying in the granite. West of this again nothing but granite occurs. Between the main line of the Canadian Pacific and Winnipeg River practically all of the schists have been removed by erosion. Farther north between Winnipeg River and Wanipigow (Hole) River, bands of schist, generally striking east and west, are common. Throughout this region the schists have been highly mineralized by emanations and ore-solutions from the granite. Sulphides of iron are widely deposited in some places, and signs of other metals are also common. Bodies of pegmatite, some of them irregular in form, but mostly in well defined dykes, cut both the granites and schists in numerous places. Beyond being a possible source of felspar or mica, the pegmatites within the granite generally have no interesting mineral occurrences. Those in the neighbouring schists, however, are all worthy of a close examination for economic or rare minerals.

In 1917 and the two or three years following, pegmatite dykes carrying interesting quantities of molybdenite were staked and investigated in the country a few miles north of Falcon Lake. In the summer of 1924 a lithium-bearing dyke was located near Winnipeg River about 10 miles north-east of Pointe du Bois. This was followed in 1925 by the discovery of tin on Shatford Lake, where K. E. Miller located a body of pegmatite on a small rock-island, containing excellent samples of cassiterite ore. An occurrence of tin had been reported in 1919 by the writer, but it was of sulphide tin in the large sulphide bodies near West Hawk Lake. No cassiterite, however, has yet been reported from the latter district or from the pegmatites carrying molybdenite in the vicinity of Falcon Lake. Since 1924 and 1925, several other occurrences of lithium minerals and cassiterite in pegmatite have been noted. The main showings of tin are near Bernic Lake but signs of it appear throughout the country between Winnipeg and Oiseau Rivers. Lithium has been found at West Hawk Lake and as far north as Cat Lake, 20 miles or more north of Oiseau River. The distance between these occurrences is about 60 miles.

The original discovery, on a small rock in Shatford Lake, has been already mentioned. The cassiterite appears in a facies of the pegmatite consisting of quartz and muscovite. It occurs in irregular grains and subhedral crystals of all sizes up to an inch or more in length. That part of the dyke containing the tin in interesting quantity, being along one margin near water-level, could not be thoroughly examined to determine its extent. After the first few shots the mineralized portion of the dyke was flooded by lake water. Some excellent specimens of tin ore were secured from this outcrop. At the present time the Manitoba Tin Company, having sunk a shaft on the neighbouring island, are cross-cutting beneath a narrow lake channel to intersect the pegmatite dyke beneath the mineralized outcrop on the rock. The presence of tin has been established at a number of points on this company's claims and an interesting find was made by them early in the present summer on the Stannite group which lies about midway between the east end of Bernic Lake and Oiseau (Bird) Lake. Here a small portion of a large pegmatite dyke is exposed. On a considerable part of the outcrop cassiterite is conspicuous in a mixture of quartz and muscovite. Other parts of the dyke carry considerable tourmaline and may also be tin-bearing.

Early in the present year the Jack Nutt Mines commenced operations near the north shore of the west end of Bernic Lake. A pegmatite dyke of considerable magnitude, carrying notable quantities of black tourmaline, is mineralized here and there by cassiterite. Specimens showing considerable amount of the latter mineral are common in rock broken from the surface of the dyke. The most consistently mineralized material is that contained in a small dyke, from a few inches to more than a foot in width, which branches off from the main body. A shaft is being sunk to intersect the main pegmatite at depth. The same company has some interesting occurrences on the Rush group, between Bernic and Oiseau Lakes, close to the Stannite group of the Manitoba Tin Company. The cassiterite on the Rush claims is in large dykes of pegmatite which also contain notable amounts of black tourmaline, and in one place apatite and other phosphates are conspicuous. The Manitoba Tin Company is also diamond-drilling and otherwise developing some sulphide bodies close to the south side of Oiseau Lake.

Small occurrences of tin have been reported from a number of other points in the district between Oiseau River and the country east of Pointe du Bois. Tin assays have been secured in one instance from sulphide ore. Another type of occurrence is within narrow bands of contact metamorphic garnet along the walls of pegmatite. Tin assays are reported also from similar bands of altered country rock which consist largely of coarse flakes of muscovite and contain columbite or tantalite.

The pegmatites of the district occur in many forms and sizes. Some are in irregular patchy outcrops but most are tabular in form. Dips vary from 0 to 90 degrees in different bodies. In width they vary from stringers to wide dykes as much as 50 ft. across. Some are uniform in width for great distances along the outcrop while others pinch and widen at intervals. Probably the greater number of dykes are parallel to the structure of enclosing rocks. Some, however, cut across these structures. Though pegmatites occur in some of the bodies of granite, the mineralized dykes appear to be all in the various schists that have been intruded by the granites. Although the greater number of pegmatite dykes in most regions carry no conspicuous minerals except those that are found in ordinary granites, exceptional dykes are likely to carry very interesting assemblages of rare minerals and a considerable content of rare elements. Many of the dykes of this district are of the latter type. In the first interesting dykes found in the region as a whole, molybdenite and some beryl occurred. Later on in the same vicinity (near West Hawk and Falcon Lakes) the lithium minerals spodumene and lepidolite were found. In the lithium-bearing pegmatites located near Pointe du Bois and far to the north in the district near Cat Lake, the following minerals occur in some of the various pegmatites: lepidolite, spodumene, amblygonite (variety montebrasite), beryl, apatite, mangan-apatite and several other complex phosphates, topaz, tourmaline, garnet, bismuth, arsenopyrite, sphalerite, columbite and tantalite, cassiterite, etc. The bulk of the pegmatite is of course made up of felspar, quartz, muscovite and some biotite, which are the common minerals of granite. Further work will no doubt bring to light others of the more uncommon minerals and possibly some of the rarer elements not contained in the minerals of the foregoing list.

The geological conditions for the occurrence of tin deposits in Manitoba are only occasionally favourable. The Precambrian areas have numerous small and large outcrops of granite. In most of the country the granite occupies large areas with little or no schist. Such areas are not promising for tin. In a few portions of the country, however, there are considerable areas where the schists outcrop more abundantly than granite and in these the possibilities for tin concentrations are better. It is in areas such as the last that Manitoba's occurrences have been found. The roof of the granite batholith and its satellites is unfavourably steep in most places, but steep contacts are more apt to be exposed than flatter ones and the latter may exist. Manitoba granites are all Pre-cambrian and so far in the world's tin production such rocks have contributed very little. Most granites carry tin but few of them have been productive sources. Evidence of the tin content of the Manitoba granites is slowly accumulating. Near West Hawk and its neighbouring lakes there is some evidence that a great deal of tin came from the batholith. It is unfortunate that in this locality most of the tin seems to occur widely scattered as sulphide tin in masses of sulphides that are numerous and large. Between Winnipeg and Oiseau Rivers, however, much of the tin occurs as the oxide.

SHORT NOTICES

Pilgrims Rest Goldfields.—*The South African Mining Review* for July 30 contains an abstract of a paper on the ore-bodies of these fields, written by L. Reinecke and W. G. A. Stein, and read before the Geological Society of South Africa.

The Crushing of Banket.—H. A. White has written a paper on the crushing and grinding of Banket, which appears in the *Journal of the Chemical, Metallurgical and Mining Society of South Africa.*

Crystal Orientation in Rolled Metal.—*Technical Publication* No. 243 of the American Institute of Mining and Metallurgical Engineers contains a description of a method of determining the orientation of crystals in rolled metal from the X-ray patterns, by Wheeler P. Davey, C. C. Nitchie, and M. L. Fuller. The patterns are obtained by the monochromatic pin-hole method.

Copper-Tin Eutectic.—Experiments to determine the eutectic composition of copper and tin, and to determine the location of the liquidus line, are described by G. O. Hiers and G. P. de Forest in *Technical Publication* No. 241 of the American Institute of Mining and Metallurgical Engineers.

Portland Canal.—*The Mining and Industrial Record* of British Columbia for August contains an article on activities in the Portland Canal district.

Microscopic examination of Ground Ore.—The *Monthly Bulletin* of the State College of Washington for April, contains an article by Arthur Eilert Drucker on the importance of preliminary ore analyses by means of the stereoscopic binocular microscope.

Copper-Calcium Alloys.—The deoxidation of copper with calcium, and the properties of some copper-calcium alloys, are described by Earle E. Schumacher, W. C. Ellis, and John F. Eckel in *Technical Publication* No. 240 of the American Institute of Mining and Metallurgical Engineers.

Bentonite.—In *Technical Publication* No. 239 of the American Institute of Mining and Metallurgical Engineers, George C. Branner describes occurrences of bentonite in southern Arkansas.

The Roasting of Zinc Ores.—*Metall und Erz* for September 1 contains an article by Dr. Georg Balz on recent advances in the solution of problems connected with the roasting of zinc ores.

Wire for Mining Ropes.—A. T. Adam delivered a paper entitled "Notes on Wire for Mining Ropes," to the Iron and Steel Institute on September 10.

Oil Wells.—Some observations on the principles involved in flowing oil wells by S. F. Shaw, are contained in *Technical Publication* No. 235 of the American Institute of Mining and Metallurgical Engineers.

Tin Dredges.—A paper read by Paul E. Morse before the Malayan Tin Dredging, Mining and Research Association on May 31, contains observations on the field erection of tin mining dredges in Malaya.

Gold in Brazil.—The *Bulletin* of the Institution of Mining and Metallurgy for September contains an article by Arthur J. Bensusan on auriferous jacutinga deposits.

Cupriferous precious-metal Ores.—*Engineering and Mining Journal* for August 31, contains an article by A. C. Halferdahl on the problem of treating cupriferous precious-metal ores by the cyanide process.

Bauxite in British Guiana.—Bauxite mining in British Guiana is described by Lawrence Litchfield, jr., in *Engineering and Mining Journal* for August 17 and 31.

Anaconda.—*The Engineering and Mining Journal* for August 24 is a special number devoted to the Anaconda enterprise. Articles have been contributed on :—Ore Discovery and Development of Fundamental Importance, by Reno H. Sales; Evolution of Mining Practice at Butte, by William B. Daly; Timber and Lumber Interests, by W. C. Lubrecht; Modern Metallurgical Miracles, by Frederick Laist; Selective Flotation of Lead-Zinc Ores at Tooele, Utah, by A. B. Young and W. J. McKenna; Both Copper and Zinc Ores Treated by Selective Flotation, by Bayard S. Morrow; Development of Copper Smelting at Anaconda, by Louis V. Bender; Promoting Sales of the Product, by J. N. McDonald; Refining Anaconda Copper at Raritan and Great Falls, by W. T. Burns; Phosphates and Sulphuric Acid, by E. L. Larison; Smelting Lead at Tooele, by J. O. Elton and B. L. Sackett; Western Lead Refined at East Chicago by Parkes Process, by G. E. Johnson; Pioneer Work in Development of White Lead Manufacture by Sperry Electrolytic Process, by R. G. Bowman; Electrolytic Zinc Practice at Great Falls and Anaconda, by Albert E. Wiggin and Russel B. Caples; Fuming Off Zinc from Lead Slags at East Helena, by Alexander Laist; Arsenicals—An Important By-product, by H. C. Gardiner; French Process Modernized by Anaconda in Production of Zinc Oxide at East Chicago, by F. O. Case; Mining the World's Largest Copper Ore Deposit at Chuquicamata, Chile, by H. C. Bellinger; Manufacturing the Raw Material, by John A. Coe; Leaching, Flotation, Smelting included in Ande's Operations at Potrerillos, Chile, by William Wraith; The Polish Enterprise, by George Sage Brooks; Anaconda Wire and Cable Company One of the Newest Subsidiaries, by H. Donn Keresey; How Anaconda Applies Electricity in Mining and Metallurgy, by C. D. Woodward; Half a Million Tons of Coal Annually Produced by Anaconda, by F. W. C. Whyte; Industrial Relations and Safety Work, by John L. Boardman.

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.

9,363 of 1928 (316,331). THE BRITISH ROPEWAY ENGINEERING CO., LTD., and H. F. H. SHIELDS, London. Improved covers for closing buckets or other carriers used on aerial ropeways, skipways, etc.

13,633 of 1928 (291,025). DR. RICHARD AMBRONN, Gottingen, Germany. New apparatus for use in geophysical investigations.

14,295 of 1928 (317,141). ALFRED ARTHUR LOCKWOOD, London. Concentrating tables, or separation apparatus, in which material is supplied to a sloping plane surface and assisted in the run down by blows applied to the surface at one or more points.

21,401 of 1928 (314,697). THE MANCHESTER OXIDE CO., Ltd., and R. H. CLAYTON, Manchester. The purification of crude sulphur by passing gaseous SO_3 through the molten sulphur.

22,588 of 1928 (296,723). RENÉ EMILE TROTTIER, Puteaux, France. Crushing mills which incorporate metal balls in between rotating plates.

22,907 of 1928 (295,991). ELECTROLYTIC ZINC CO. OF AUSTRALASIA, LTD., Melbourne. The use of copper-cadmium alloys as bearing metal, and also similar alloys containing up to 0·5% magnesium.

23,098 of 1928 (314,261). WILSON EVANS, Chicago, Illinois. A method and apparatus for mixing solids with liquids.

25,857 of 1928 (317,652). A. KNAFF, LEON MAYER, and PAUL GREDT, Luxembourg. Ore-briquetting improvements, mainly in the use of iron compounds of low oxidation stages mixed with substances such as finely divided metals or metallic ores, or other substances which accelerate oxidation by moist air, the whole effect being a binding of the briquettes.

28,240 of 1928 (317,665). JOHN BURNS READ and MELVILLE FULLER COOLBAUGH, Golden, Colorado. A method of roasting sulphide ores prior to leaching.

28,794 of 1928 (298,636). METALLGESELLSCHAFT A.-G., Frankfort-on-Main, Germany. A process for the production of metallic zinc from oxidized zinc compounds.

30,219 of 1928 (299,773). EMIL ABEL, Vienna. Improved lead bearing metals which contain nickel and copper. The copper content is at least 1½ times the nickel content, in order that the nickel may be present as non-magnetic β-nickel. The copper is usually less than 1·5% and nickel less than 1%.

30,839 of 1928 (299,375). SOCIÉTÉ ANONYME "LE NICKEL", Paris. In electrolytic extraction of metals from solutions the use of one or more independent wires is proposed for the primary cathode. A metal ingot is built up by continuous electro-deposition on a filiform core.

33,356 of 1928 (300,559), and 35,567 of 1928 (301,739). PETER MARX, Hennef-on-the-Sieg, Germany. The production of a cupola furnace for the simultaneous smelting and refining of iron.

37,681 of 1928 (305,201). VANADIUM CORPORATION OF AMERICA and B. J. SAKLATWALLA. Ferro-vanadium alloys containing 85 to 95% vanadium, for use in the manufacture of vanadium steels.

10,568 of 1929 (315,208). BOHUSLAV STOCES, Czechoslovakia. Improvements in methods for cooling mine air.

19,163 of 1929 (314,032). CLIMAX MOLYBDENUM Co., Delaware, United States. The preparation of ferrous molybdenum alloys, by mixing molten molybdenum-bearing pig iron into another molten ferrous alloy.

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.

The Platinum Deposits and Mines of South Africa. By DR. PERCY A. WAGNER. Cloth, octavo, xv + 326 pages, illustrated. Price 21s. Edinburgh and London: Oliver and Boyd.

Petroleum Development and Technology, 1928-29. Cloth, octavo, 623 pages, illustrated. Price $5. New York: American Institute of Mining and Metallurgical Engineers.

Select Methods of Metallurgical Analysis. By DR. W. A. NAISH and J. E. CLENNELL. Cloth, octavo, 495 pages, illustrated. Price 30s. London: Chapman and Hall.

Gisements Pétrolifères de la Perse. By C.-P. NICOLESCO. Folio, paper backs, 80 pages, illustrated. Price 50 francs. Paris: La Revue Pétrolifère.

Tanganyika Territory. Mines Department Annual Report, 1928. Paper, 14 pages. Price 2s. Dar es Salaam: The Government Printers.

The Geology of the Country Surrounding Pretoria. By H. KYNASTON, revised by L. J. KRIGE and B. V. LOMBAARD. Paper backs, 48 pages, illustrated, with map. Price 5s. Pretoria: The Government Printer.

The Geology of the Gaika Gold Mine, Que Que, S. Rhodesia. By S. C. MORGAN. Geological Survey Bulletin No. 14. Paper backs, 42 pages, illustrated, with map. Salisbury: The Rhodesian Printing and Publishing Co., Ltd.

An Outline of the Geology of Southern Rhodesia. By H. B. MAUFE. Paper, 12 pages, with maps. Short Report No. 24, of the Southern Rhodesian Geological Survey.

Geologie et Minéralogie Appliquées. By HENRI CHARPENTIER. Paper backs, octavo, 760 pages, illustrated. Paris: Dunod.

Group Administration in the Gold Mining Industry of the Witwatersrand. Address delivered by JOHN MARTIN, before the Economic Section of the British Association in Johannesburg, 1929. Paper backs, 25 pages, with appendix and plan. Johannesburg.

Rationalisation for Tin. By A. P. L. GORDON. Paper boards, octavo, 84 pages. Price 2s. London: The St. Catherine Press.

Deposition of the Sedimentary Rocks. By PROF. J. E. MARR. Cloth, octavo, 245 pages, illustrated. Price 7s. 6d. Cambridge: The University Press.

Reports of H.M. Inspectors of Mines, 1928. 4. North Midland Division. By J. R. FELTON. Paper backs, 49 pages, illustrated. Price 1s. London: H.M. Stationery Office.

The Ignition of Firedamp by the Heat of Impact of Metal against Rock. Safety in Mines Research Board paper No. 54. By M. J. BURGESS and R. V. WHEELER. Paper backs, 25 pages, illustrated. Price 6d. London: H.M. Stationery Office.

South Australia. Mining Review for the half-year ended December 31, 1928. No. 49. Paper backs, 93 pages, illustrated. Adelaide: The Government Printer.

British Guiana. Report of the Diamond and Gold Industries Commission. Paper folio, 46 pages. Georgetown: The Government Printers.

Zinc in 1927. By ELMER W. PEHRSON. Paper backs, 30 pages. Price 5 cents. Washington: Bureau of Mines.

Inflammability of Mixed Gases. By G. W. JONES. Paper backs, 38 pages, illustrated. Price 10 cents. Technical paper 450, Washington: Bureau of Mines.

Calcium Sulphate Retarders for Portland Cement Clinker. By ERNEST E. BERGER. Paper backs, 35 pages, illustrated. Price 10 cents. Technical paper 451, Washington: Bureau of Mines.

Petroleum. Bibliography of Petroleum and Allied Substances, 1922 and 1923. Paper backs, 667 pages. Price $1. Bulletin 290, Washington: Bureau of Mines.

The Witwatersrand Gold Field. A Brief Survey. Issued in connection with the fifteenth session of the International Geological Congress, South Africa, 1929. Paper backs, 23 pages, illustrated. Johannesburg: Transvaal Chamber of Mines, Gold Producers' Committee.

Transvaal Chamber of Mines. Thirty-ninth Annual Report. Year 1929. Cloth, quarto, 172 pages. Johannesburg.

The Pressure produced on Blowing Electric Fuse Links and Striking Electric Arcs in Closed Vessels. By G. ALLSOP. Paper backs, 19 pages, illustrated. Safety in Mines' Research Board, Paper No. 52. Price 1s. London: H.M. Stationery Office.

Coal Dust, Firedamp and other Sources of Danger in Mines. Index of Reports and Papers relating to Research Paper backs, 11 pages. Safety in Mines' Research Board, Volume iii. Price 2d. London: H.M. Stationery Office.

The Restless Earth. By PROF. H. L. HAWKINS. Paper backs, pocket size, 76 pages, illustrated. Price 6d. London: George Routledge and Sons.

The Ignition of Firedamp. By H. F. COWARD and R. V. WHEELER. Paper backs, 40 pages, illustrated. Price 6d. Safety in Mines Research Board Paper No. 53. London: H.M. Stationery Office.

The Mineral Industry during 1928. Vol. xxxvii. Edited by PROF. G. A. ROUSH. Cloth, octavo, 802 pages, illustrated. New York and London: McGraw-Hill.

Advanced Mine Rescue Training. Part IV. Suggested procedure in sealing and unsealing mine fires and in recovery operations. By J. J. FORBES and G. W. GROVE. Paper covers, 54 pages, illustrated. Price 15 cents. Miners Circular 36. Washington: Bureau of Mines.

The Mining Laws of the British Empire and of Foreign Countries. Vol. V. Australia. Part I. New South Wales. Boards, octavo, 378 pages. Price 21s. London: H.M. Stationery Office.

COMPANY REPORTS

Consolidated Main Reef Mines and Estate.—This company, now controlled by Central Mining-Rand Mines, was formed in 1896. The properties worked are on the middle West Rand. The report for the year ended June 30 shows results which are not so good as in the previous year. The tonnage of ore milled, 710,800, was greater by 6,300, but the recovery was not so high, resulting in a decline of 3d. per ton in working revenue. Working costs at 26s. 4d. per ton were higher by 7d. per ton, which resulted in a decrease in working profit of £27,699. The total working profit was £208,929. The ore reserves have been increased to 1,985,700 tons, but there is a fall in value to 7·5 dwt. per ton. Developments on the Main Reef Leader were not so favourable as in the previous year. It is intended, during the current year, to make improvements in hoisting and pumping arrangements, and also to improve the slime plant.

Nourse Mines.—This company, operating a mine on the Central Rand, has issued its report for the year ended June 30. The report shows that 728,580 tons of ore, averaging 6·07 dwt., were sent to the mill, and that gold to the value of £892,729 was obtained. In addition silver and osmiridium valued at £4,445 were won. The total working revenue of £897,174, equal to 24s. 7d. per ton, shows a decrease of 1s. 4d. per ton compared with the previous year. The working profit was £53,854, equal to 1s. 6d. per ton milled, a decrease of 1s. per ton, the decrease being due to a fall in the value of ore milled. £19,592 was distributed as dividend, equal to 2½%. The ore reserve has been re-estimated, and stands at 1,266,700 tons of an average value of 5·9 dwt. over 43 in. stoping width. 358,900 tons were developed during the year, a decrease of 177,090 tons on the previous year. This, together with the fall of 187,500 tons in the reserves is due to a large amount of mining from reserves to keep the mill supplied when labour has been short.

Modderfontein East.—The plant capacity of this company was increased to 60,000 tons per month in 1925, and the report for the year ended June 30 shows that the tonnage treated was 775,500, an increase of 54,500 tons on the previous year. A slight decrease in the yield per ton milled, from 6·23 to 6·19 dwt., was offset by increased sales of osmiridium and working revenue was increased from 26s. 6d. to 26s. 7d. per ton milled. 240,005 oz. of gold were obtained, worth £1,017,123 or 26s. 3d. per ton, together with 18,669 oz. silver worth £2,484 and osmiridium to the value of £9,438. The working cost was £800,719, or 20s. 8d. per ton, leaving a working profit of £228,326, out of which two dividends equal to 20% absorbed £185,776. Development was further expanded during the year, the footage accomplished being 52,473. The ore reserves were re-calculated as at June 30, and amounted to 2,045,200 tons, an increase of 103,300 tons, of an average value of 6·1 dwt. per ton over an estimated stoping width of 46·5 in. In addition there are 63,300 tons of ore in shaft and safety pillars, which are not yet available for working.

Onverwacht Platinum.—The report for the year ended June 30 shows that this company, formed in 1926, did not have such a favourable year as in the previous one. The amount of ore milled was 28,069 tons, estimated to average 4·894 dwt. of platinum and allied metals, and concentrates estimated to contain 5,655 fine ounces of recoverable values were obtained. The extraction amounted to 84·885%, which is an improvement on the previous year. The revenue from the sale of concentrates was £68,156, and the working profit was £22,211. Dividends amounting to £22,500 were paid, equal to 5%. Compared with the previous year there was a small increase in the tonnage milled, but the yield of concentrates was lower, consequent on decreased ore value. Exploration of the ore-body in depth is being continued, but the results are not favourable, and the Government has been warned that stoping operations may be expected to cease in the near future.

Rooiberg Minerals Development.—This company was formed in 1908 to work tin-mining properties in the Waterberg district, Transvaal. The report for the year ended June 30 shows that 17,611 tons from the Rooiberg property and 12,479 tons from Nieuwpoort were raised. 29,148 tons of ore were sent to the mill, resulting in a recovery of 444 tons of tin concentrates, equal to 288 tons of metallic tin. The revenue was £63,310, and the working profit £8,037, out of which £4,500 was paid as dividend, equal to 2½%.

Gaika Gold Mining.—Formed in 1902, this company works properties in Southern Rhodesia. The report for the year ended April 30, shows that 76,522 tons of ore was milled, yielding 12,493 oz. of gold. Total gold obtained including that from the Cyanide plant was 23,074 oz. Probable ore reserves are estimated at 47,740 short tons, averging 6 84 dwt. Extensive development work has been done, the drivage amounting to 7,903 feet, and as a result of the geological examination by the Southern Rhodesian Geological Survey a shaft has been commenced which aims at cutting the main reef to the north of the old deep level workings. The net profit for the year was £7,937.

Rhodesian Corporation.—Among its wide interests in Rhodesia this company works the Fred, Turkois, and Redwing mines, of which only the Fred mine is in the producing stage. The report for the year ended December 31 last shows that at this mine 17,600 tons of ore were milled, yielding 12·71 dwt. per ton. The working profit on these operations was £14,529. The reserves of the Fred mine are estimated at 53,200 tons containing 27,664 oz. of gold. During the period under review 2,780 ft. of development work was completed. On the Turkois mine the principal work done was on reorganization of plant, but the tributing agreement on the Redwing mine has now expired and the company is resuming work on the property. This corporation is also interested in the Wanderer Consolidated Gold Mines, which are being developed, and also in a copper property. The year's operations resulted in a profit of £15,583. To acquire further properties it is the intention of the directors that the capital of the company should be increased from £1,000,000 to £1,100,000, by the creation of 400,000 new shares of 5s. each.

Renong Tin Dredging.—This company, which was formed in 1913 to take over the Renong Dredging Co., has issued the report for the year ended June 30. During the year 654 tons of tin concentrates were obtained, and trading profit amounted to £40,160, of which £27,247 was distributed as dividends. A mining title to 182 acres in the Gombak Valley has been issued to the company.

Larut Tin Fields.—This company was formed in 1926 to consolidate several tin dredging undertakings in Malaya, and is controlled by the Anglo-Oriental group. The report for the year ended December 31, 1928, shows that 952 tons of tin concentrates was recovered, which realized £126,505. The working profit was £49,390, of which £45,000 was distributed as dividends, equal to 7½%.

Kinta Kellas Tin Dredging.—This company, formed in 1926, works ground on the Kinta Kellas Rubber Estate on a royalty basis. The report for the year ended March 31 shows that the first dredge commenced work in August, 1928, and by the end of the financial year had treated 626,454 cubic yards of ground, recovering 209 tons of tin concentrates. The working profit was £12,130 of which £5,000 was distributed as dividends equal to 5%. Plans for a second dredge are being considered, and it has also been recommended that the capital of the company be increased to £150,000 by the creation of 50,000 new shares of £1 each.

Jelapang Tin Dredging.—This company, formed in 1925, is controlled by the Anglo-Oriental group. The report for the year ended December 31, 1928, shows that 339 tons of tin concentrates was recovered which realized £41,725. The working profit was £17,794, of which £10,000 was transferred to General Reserve account and £3,000 distributed as dividend, equal to 2½%.

Rukuba Tin Mines.—This company was formed in 1924 as a reconstruction of the Rukuba (Nigeria) Tin Mining Co., and works alluvial tin properties in Northern Nigeria. The report for the year ended March 31 shows that the output of tin concentrates was 55¼ tons, compared with 96 tons in the previous year. On the year's working there was a debit balance of £424, whereas there had been a profit of £1,168 in 1927. The loss is attributed to the low price of tin. On the Rukuba areas the reserves are estimated at 750–800 tons. The Kaleri property has been let on tribute.

Levant Tin Mines.—This company, formed in 1920 to take over the property of the Levant Mining Co., works a tin mine at Pendeen in Cornwall. The report for the year ended March 31 shows that 29,292 tons of ore were mined, and with 13,571 tons from the dump, was sent to the mill. 414 tons of tin concentrates was recovered, equal to 26·6 lb. per ton, and yielding £43,949. In addition copper ore to the value of £361 was recovered. The working costs were £42,266, and the working profit £2,043, but the year's working resulted in a net loss of £395. 305 fathoms of development work were done during the year as against 482 fathoms in the previous year.

Pena Copper Mines.—Formed in 1900, this company works copper properties in the Huelva district, Spain. The report for the year ended December 31 last shows that 101,136 tons of ore were mined as compared with 112,632 tons in the previous year. The ore won was mainly added to the leaching dumps, 78,160 tons being treated in this way. The remaining 22,976 tons was exported. 765 tons of cement copper were produced during the year. The profit on the year s working was £28,569, of which £10,752 was distributed as dividends, equivalent to 7½%.

Murex.—This company, which owns a process for the separation of complex ores and which is also interested in tungsten, has issued its report for the year ended June 30. The company has acquired the control of Thevwit, Ltd., and of the Pure Metal Manufacturing Company, Ltd. During the year under review no concentrates from the Mawchi Mines have been treated, but regular shipments are expected to start again next March. The working profit for the year was £20,982, of which £12,280 was distributed as dividends, equal to 15%.

DIVIDENDS DECLARED

Amalgamated Mining Trust.—1s., less tax, payable October 24.

Broken Hill Proprietary.—B Debentures, 7%, payable October 1.

Broken Hill South.—1s. 6d., less tax, payable November 15.

Crown Diamond.—7½%, payable November 27.

English China Clays.—1½%, payable October 1.

Gopeng Consolidated.—9d., less tax, payable September 30.

Idris Hydraulic Tin.—3d., less tax, payable September 28.

Jelapang Tin Dredging.—6d., less tax, payable September 28.

Kepong Dredging.—6d., less tax, payable September 26.

Kinta Tin.—3d., less tax, payable September 28.

Kundang Tin Dredging.—6d., less tax, payable September 28.

Larut Tin.—6d., less tax, payable September 28.

Mexican Corporation.—1s., less tax, payable October 24.

Mysore Gold.—9d., less tax, payable October 12.

Nevada Consolidated Copper.—75 cents, payable September 30.

New Jagersfontein.—2s., less tax.

Ooregum Gold.—Pref. 1s. 6d.; Ord. 6d., less tax, payable October 26.

Pena Copper Mines.—7½%, less tax, payable October 1.

Pengkalen.—Pref. and Ord., 10%, less tax, payable October 25.

Renong Tin Dredging.—2s., less tax, payable October 12.

Rio Tinto.—25s., less tax, payable Nov. 1.

Siamese Tin.—6d., less tax, payable October 4.

Sungei Besi.—1½d., less tax, payable September 27.

Taiping Tin Dredging.—5%, less tax, payable October 22.

Tanganyika Diamonds.—1s. 3d., less tax.

Tanjong Tin.— 3d., less tax, payable September 28.

Tin Selection Trust.—1s., less tax, payable September 24.

Transvaal G.M. Estates.—6d., less tax, payable November 5.

Tronoh Mines.—4½d., less tax, payable September 30.

Utah Copper.—$4, payable September 30.

Waihi Gold.—1s., payable November 1.

Wankie Colliery.—5%, less tax, payable September 30.

NEW COMPANIES REGISTERED

The Anglo-Hellenic Mining Corporation.—Registered as a private company. Capital: £500 in £1 shares. Objects: To acquire any concessions, mining leases and rights in any part of the world and to quarry for asbestos, diamonds, gold, copper, etc.

Ariston Gold Mines (1929). — Registered August 30. Capital: £500,000 in 5s. shares. Objects: To acquire the mines, mining claims and rights and undertaking of Ariston Gold Mines, Ltd., to adopt an agreement with the old company and its liquidator, and to carry on the business of miners, prospectors and explorers; to obtain information in reference to mining and other districts in Africa, to act as agents between owners of mining claims in Africa and investors in Europe, and negotiate the sale of properties, etc.

Ferreira Estate.—Incorporated in South Africa in June, 1929. Capital: £192,765 in £1 shares. Objects: To acquire the property, rights and assets of the Ferreira Deep (except £120,478 5s. cash).

Golden Horse Shoe (New).—Registered as a public company. Capital: £220,000 in 4s. shares. Objects: To acquire the Golden Horseshoe Estates, to adopt an agreement with the old company and the liquidator, and to acquire mines, properties and rights in Australia or elsewhere.

Killinghall Tin. — Registered September 19. Capital: £160,000 in 5s. shares. Objects: To adopt an agreement with A. G. Glenister, of Ipoh, Perak, F.M.S., on behalf of the Klang Prospecting Syndicate, to acquire any mines, mining, water, and other rights, and mining claims in any part of the world; to prospect and explore mines and grounds containing metals, minerals, or precious stones; to carry on the business of rubber estate owners and planters and growers of rubber, gutta percha, coffee, rice, cocoanuts, and other products in the Malay Peninsula and any other part of the world; to manufacture and deal in tin, bullion, precious metals, and minerals of all kinds, etc.

Lake George Metal Corporation.—Registered as a public company. Capital: 1,000,000 in £1 shares. Objects: To acquire lands, farms, mines, mineral and other properties and mining, water and other rights in the Commonwealth of Australia or elsewhere, to adopt an agreement with Camp Bird, Ltd., for the acquisition of the property comprised therein, and to carry on the business of miners, explorers, prospectors, mineowners, colliery proprietors, etc.

Manganese Fields.—Registered at Pretoria. Capital: £100,000 in 2s. 6d. shares. Objects: To take over the Postmas Manganese Co. and Gamagara Manganese Corporation, each of which has a capital of £40,000.

Naraguta Extended Areas. — Registered August 26. Capital: £110,000 in 2s. shares. Objects: To acquire the undertaking of the Naraguta Extended (Nigeria) Tin Mines, Ltd. (incorporated in 1911), and to adopt an agreement with the said old company and H. T. Skipp, the liquidator thereof, to acquire and turn to account any lands, mines, mining rights, oil rights, water and timber rights, etc.

Rhodesia Minerals Concession.—Registered August 14. Capital: £200,000 in 5s. shares. Objects: To acquire the undertaking and assets of Rhodesia Minerals Concession (incorporated in 1924), to adopt an agreement with the said old company and its liquidator and the British South Africa Company, to acquire mines and mineral properties, explore, develop and maintain copper, gold, silver, coal, iron and other mines, mineral and other rights and properties, etc.

South Bukeru Areas.—Registered as a public company. Capital: £35,000 in 2s. shares. Objects: To acquire the undertaking of the South Bukeru (Nigeria) Tin Company (incorporated in 1910).