The Mining Magazine

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EDITORIAL

IT is satisfactory to note that at the annual meeting of the Court of Governors of the London School of Hygiene and Tropical Medicine, held last month, a resolution approving amalgamation with the Ross Institute was carried unanimously.

WITH the passing of Charles Butters—an appreciation of whose work and character appears elsewhere in this issue—hydro-metallurgy has lost one of its ablest pioneers, a "giant" whose aid in the solution of Rand ore-dressing problems in the early days will always be remembered.

IN a recent *Bulletin* [1] of the Imperial Institute there appears a short review of the mineral resources of British Guiana. Readers of the MAGAZINE are already aware that an economic geological survey of part of the Colony is now under way and the article referred to emphasizes its potentialities as a producer of gold, diamonds, and bauxite.

THE rehabilitation of the British iron and steel industry was advanced a step further last month when the English Steel Corporation announced its decision to spend approximately an additional £500,000 in continuing the programme of modernizing its extensive plant at the Vickers Works, Sheffield. It was stated that the available funds are to be used chiefly on the extension of the drop-forging plant, on the improvement of heat-treatment processes, and on the installation of a new open-hearth furnace.

THE main conclusions that can be derived from a Survey of the mineral resources of the Empire were carefully reviewed a year or two ago by the Mineral Resources Department of the Imperial Institute, their report being examined in the MAGAZINE for March, 1931. A brief review of the position has again been made by the same authorities in a recent *Bulletin* [1] of the Institute, their main conclusion being that "as regards degree of independence in the matter of mineral supplies the Empire need not fear comparison with the rest of the World."

[1] Vol. XXXI, No. 3, 1933.

FUEL research prosecuted in this country is now moving along lines which clearly show how much the Advisory Council of the Department of Scientific and Industrial Research have at heart the well-being of the basic industries. The report of the Fuel Research Board for the year to March 31 last, which has just been issued, covers a great deal of ground and it is evident that the broad view has been adopted in the endeavour to help the manufacturing industries in their struggle to increase their competitive power. The economical use of fuel and its use as a raw material in the chemical industry are dealt with extensively in the report.

GOLD production from the Gold Coast Colony becomes an increasingly important factor in its development, the premium that has been obtained since September, 1931, having proved of immense help in the resuscitation of the industry. The report of the Mines Department for the year to March 31 last shows that gold bullion produced was valued at £1,210,003, against £1,123,266 in the previous year, the quantity being 284,841 oz., against 264,422 oz. The production of diamonds also increased from 790,737 carats, worth £383,585, to 863,722 carats, worth £560,284, but the manganese ore industry declined sharply, production being estimated at 73,099 tons, valued at £122,582, as compared with 218,637 tons, worth £339,252, in the previous year. Many parts of the Colony are now being prospected for gold, while several old mines are being reopened.

Mining Engineers and the Public

The state of world affairs during the past few years has been such that the base-metal mines already in existence have a capacity far in excess of the current demand for their products, so that flotations of enterprises of this character have been few and far between. Since 1931, however, when

this country left the gold standard, gold properties have been urgently sought for and the past two years have witnessed a revival of interest in many goldfields—even the discovery of new goldfields—a resumption of development on properties long derelict, and an intensification of activities on mines already operating. The position of gold properties, therefore, has largely improved as a medium for investment and it is not surprising that during recent months the public has been asked to aid in the resuscitation of the industry. The appearance of a prospectus relating to a mining property is always of interest to members of the profession and the sections of engineers' reports reproduced therein for public consumption are eagerly read and, quite properly, subjected to close examination. In certain cases the consulting engineer to a new company may have been unable to visit the property and his opinion of the work of those who have actually examined it is then generally quoted. The propriety of this course of action has frequently been in question and it is not surprising, therefore, that the Institution of Mining and Metallurgy should have been asked for a ruling on the matter. Their statement, brief and circumspect as it is, is thus timely and no further excuse is needed for its examination here.

The Council of the Institution, while realizing the impossibility of giving a ruling that will cover every circumstance, considers that a member "if called upon to make a report intended for publication in a prospectus and based on the statements of other persons may properly do so if he states clearly that he has not visited or examined the property for the purposes of such report and provided that he confines it to (*a*) a recital of the names of the engineers who have inspected the property and whose reports have been examined, stating the dates of these reports and for whom they were made, (*b*) a summary of the conclusions of such reports, (*c*) an expression of opinion as to the value of the reports, with reasons for such an opinion, and (*d*) recommendations as to the appropriate action that might be taken." The Council is further of the opinion that a member in such a case should exercise extreme care in presenting for publication any estimates of his own relating to quantities, values, costs, or profits. Members are also reminded of a ruling made in October, 1904, by which they were advised that reports for publication should be distinctly dated and reproduced in full, or, if summarized, that the summary should be approved and signed by the member. The ruling of the Council goes a long way towards reminding the examining or consulting engineer of his responsibility to a technically-uneducated investing public, but it may seem to many that it still falls far short of perfection—if this is possible of attainment—and probably the last word has not been heard on the matter.

In a correctly-ordered world no engineer scrupulously conscious of the integrity of his reputation would, of course, consent to pass an opinion on a property he had not seen, but in mining, as in most other matters, Utopia still seems a long way off. It is also well known that the flotation of a property is nowadays an operation that cannot be lightly undertaken and in these circumstances it would seem that those responsible might well incur the further expense of requesting their consultant to visit the property personally. It is, perhaps, too much to hope that such a course of action would always be possible and the views of the Institution may then well apply, but any engineer expressing an opinion on the reports of others should be fully satisfied as to the claims of the original investigators to act as the actual sponsor of an appeal for public money.

Rand Labour

Conditions in the Rand gold-mining industry consequent on the departure of the Union from the gold standard have already been the subject of comment in these columns. In February last the position was reviewed in the light of a speech made by Mr. John Martin, president of the Transvaal Chamber of Mines, while in April an examination of the progress made after three months' work under premium conditions revealed that three elements of uncertainty had to be carefully considered before any prophecy as to the future course of the industry could be made. One of these—the future of gold—remains still a problem, although it is generally held that the position of the metal as an international exchange standard is comparatively secure. Another—the taxation question—was cleared up to some extent by the provision made in the last South African Budget. The third—the wages question—has recently come to the fore, as trouble with the white labour element, whose repre-

sentatives are urging a drastic revision of their working conditions, has tended to become more acute.

Towards the middle of last month a deputation of white miners submitted their demands to the Chamber of Mines. These—embodying the setting up of a 40-hour week and an increase of 20 per cent. in wages—were rejected by the Chamber, which was subsequently asked to consider an alternative request for a bonus allowance such as was made in 1924. A similar proposal put forward by the surface and underground officials' organizations had been previously turned down and a like fate attended that suggested by the miners. The owners' representatives were then asked to state what they would be prepared to do and on November 27 it was announced that the Chamber of Mines proposed that the companies should contribute £300,000 per annum to the miners' benefit societies, a proposal that evidently proved unattractive to some of the men, as strikes on one or two mines followed, although so far the trouble has not spread to any extent. Nevertheless, it is evident that the last has not been heard of the subject and it is satisfactory that the native labour force has not joined in the agitation for an increased participation in the gold premium benefits.

Reviewing the problem in its broad aspects, it is evident that, apart from pure sentiment, there is little justification for the demands put forward by the men, for the cost of living has not increased, as far as can be ascertained from the latest statistics available, while working conditions continue to improve as the highly-specialized technique of the industry advances. It is quite certain that an increase in the pay of white labour on the gold mines, where men are already well paid, would not add to the contentment of those engaged in other industries. It is, perhaps, not sufficiently apparent to those responsible for the agitation that a large share of the premium is taken by the Government, a measure of appropriation which must serve to generally lighten the incidence of taxation. In addition, the position of the capitalist investor—that much maligned class—is all too frequently ignored. A return to the dividend-paying stage of capital invested in enterprises long derelict or barely surviving may surely be considered as a just reward for the support of a wage-earning class in harder times. Whilst labour is always ready to share in prosperity employers are invariably left unaided to shoulder adversity. In one other respect, too, the present state of the Rand industry is likely to be of benefit to the workers, the security of their position being greatly enhanced by the opportunity now available for the milling of ore of a lower grade than has hitherto been possible, in which connexion it would seem that the agitation on their behalf for a review of the low-grade ore problem made so urgently a short time ago has already been forgotten. So much for the ethics of the situation. In practice something might, perhaps, be done to meet the views of the workers and the offer by the Chamber of Mines of a large donation to the men's benevolent institutions is a step in the right direction, although it may be felt in some quarters that the figure named does not err on the generous side. Further measures in the interests of peace—when peace is so urgently needed in an industry of such vast importance to the Union—might be in the direction of sectional wage increases or bonus payments to lower-paid grades of employees so long as these can be made in a way not likely to affect general labour conditions in the country.

"Chlorine Smelting with Chloride Electrolysis"

A metallurgical process that has been slowly evolving over a long period and with which many well-known workers have been connected was recalled to the minds of members of the Institution by the paper by Mr. E. A. Ashcroft presented at the November meeting. The title, "Chlorine Smelting with Chloride Electrolysis"—a digest of which appears elsewhere in this issue—is self-explanatory and the author's connexion with this work was sufficiently well known to ensure a well-attended gathering, anxious to learn the position of a process that possesses many novel features. Unfortunately the author was unable to be present, but he had prepared a written introduction, and, at the invitation of the President, this was read by Dr. Sydney Smith.

The opinion widely held at the present time with regard to the process is, perhaps, as the author himself fears, that the method is "a lost cause" and one of the main objects of the paper is an endeavour to correct this impression, for, to quote his words, chlorine smelting "may yet live to confer benefits on the world, because the technical method

is sound and the difficulties encountered—though formidable—have been for the most part already surmounted." Reviewing the history of the process, Mr. Ashcroft recalls the discovery by Maxwell Lyte, in 1895, that chlorine gas will react with metallic sulphides, producing metal chlorides and sulphur chloride, a discovery amplified in 1896 by Swinburne, who found that at " high temperatures " sulphur and not sulphur chloride was the product of reaction and in 1897 patented a cyclic process for the treatment of sulphide ores involving (1) a chlorine smelt, (2) precipitation of other metals with zinc by fractional electrolysis, and (3) recovery of the zinc and chlorine by the electrolysis of the fused zinc chloride. The author became associated with Swinburne in 1898 and together they patented a method by which the chlorine reaction is carried out by suspending the ore in a mobile melt of the mixed fused chlorides of the metals and bubbling chlorine through the suspension, the apparatus used resembling a large thin-walled Bessemer converter. The chlorination operation in the larger trials that followed was shown to be abundantly self-heating and, finally, the resulting zinc chloride proved to be amenable to electrolysis in the fused state in single-couple cells. The idea of multiple-couple cells followed and a great deal of work was done by a private company along these lines with Broken Hill, Tasmanian, and British ores before it was compelled to cease work for lack of funds. After the War the matter was again taken up by the author in collaboration with the late Mr. H. G. Lacell, culminating, in 1926, in the conduct of large-scale experimental work at Wolverhampton in a plant capable of treating one ton of Broken Hill zinc concentrates per day, which was said to be quite successful and later, in conjunction with some of the Broken Hill companies and Messrs. Bewick, Moreing, and Co., was transferred to Avonmouth and enlarged so as to deal with 10 tons of zinc concentrates daily. This work confirmed the feasibility of the chlorine-smelting operation, the fractional precipitation of the other metals by zinc, and the production of melts of pure zinc chloride, all in continuous large-scale operations, but it broke down at the electrolysis of the fused zinc chloride. This failure the author believes he has now overcome and the second part of his paper reviews the various possible modifications of the process in technical detail. In the third part the economics of the process are discussed, the author being satisfied that cells can be designed to-day capable of producing zinc at a total power expenditure of less than 1 k.w. hr. per lb. and lead at about 250 watt-hrs. per lb. Finally Mr. Ashcroft is of opinion that there is now justification for the setting up of a semi-commercial installation employing the chlorine smelting process first, for the treatment of lead concentrates and then for zinc concentrates, and using in the last stage single-couple cells in the first place and then passing on to the use of cells of the multiple-couple type.

The discussion was opened by Mr. H. L. Sulman, who recalled Mr. Ashcroft's paper of 35 years ago and spoke appreciatively of the immense amount of thought and labour he had spent on this work. Pointing out that the process outlined was cyclic in operation, he felt that the dangers were only too well known, so easy was it for the component stages of the cycle to get out of step. It was difficult to believe that chlorine could compete with carbon and oxygen and neat as were the first and final steps of the process—the converter operation and the electrolysis of the fused chloride—the unpleasantness of the intermediate operations —*i.e.*, the lixiviation of the fused melt and the preparation of the pure zinc chloride liquor and its subsequent concentration—had been too readily glossed over. Further, Mr. Sulman thought that the fuel consumption needed to be carefully examined, as well as the large amount of plant space that would be required for these concentration stages. Mr. Stanley Robson, who followed, gave an account of the Avonmouth work outlined in the paper, emphasizing the importance of the purification of the fused electrolyte, and stated that it was unfair in a sense to think that the process has not been thoroughly tested, as an immense amount of money had been spent on the large-scale experiments, concluding with an appreciation of the attitude of the companies involved in permitting the details of this work to be published. The discussion was continued by Dr. H. J. T. Ellingham, who pointed out that if the process proved to be of ultimate commercial value it would be the first case of a fused-salt process being more successful than one involving the use of a wet electrolyte. Dr. W. Cullen and Mr. Donald Campbell also spoke, the time available proving all too short for the discussion of a paper that had aroused widespread interest.

REVIEW OF MINING

Introduction.—The statistics available continue to point to the growing industrial stability of this country. The revenue figures may be considered decidedly good and the same can be said of those covering unemployment, a further reduction of 31,000 being shown at the end of November. While confidence is growing in this country, however, the state of world affairs in general is not so encouraging. The position of base-metal prices shows little change over the past month.

Transvaal.—The output of gold on the Rand for November was 847,412 oz. and in outside districts 51,056 oz., making a total of 898,468 oz., as compared with 908,888 oz. in October. The number of natives employed in the gold mines at the end of November totalled 233,657, as compared with 231,799 at the end of October.

The white labour position on the Rand has continued to provide an element of uncertainty during the past month, owing to the agitation for increased pay and shorter hours. On the other hand, the native labour question has been cleared up by the decision of the Union Government to lift the ban on the recruitment of natives from the Northern territories.

The report of Glynn's Lydenburg for the three months to October 31 last states that the company has purchased the Barnard block of 67 claims, previously held under a tributing lease.

Shareholders of West Springs were informed last month that a bore-hole had struck the reef 200 ft. below the No. 2 S.E. haulage, values at the point of intersection being given as 800 in.-dwt.

An accident at the Van Ryn Deep early this month resulted in the collapse of the sub-shaft engine chamber on No. 10 level. It is stated that approximately six months will elapse before the shaft is recovered.

The accounts of the Consolidated Gold Fields of South Africa for the year to June 30 show a profit of £467,283. After adding the sum brought in and deducting preference and ordinary dividends paid during the year there was an available balance of £298,474, of which £281,096 is to be distributed as a final dividend, equal to 2s. 3d. per share, leaving £17,378 to be carried forward.

It was announced last month that the Johannesburg Consolidated Investment Company is acquiring, through the Anglo-Transvaal Consolidated Investment Company, a substantial interest in the Rand Leases (Vogelstruisfontein) Gold Mine, near Roodepoort.

At an extraordinary meeting of East Rand Consolidated, held last month, resolutions proposing an increase in the capital to £1,500,000 by the creation of 2,000,000 new 5s. shares was approved. By this means the company will be enabled to give effect to its purchase of the farm Spaarwater from Lace Proprietary Mines, the latter accepting 1,000,000 of the new shares as consideration.

Shareholders of Onverwacht Platinum were informed last month that as a result of extraordinary general meetings held in Johannesburg the company has been placed in voluntary liquidation.

South-West Africa.—The report of the South-West Africa Company for the year to June 30 last shows that the amount available was £93,963. A dividend equal to 5%, together with a bonus of 2½%, will absorb £39,886, leaving £54,077 to be carried forward. During the year the company combined with the Otavi Mining and Railway Company in acquiring a substantial interest in the Hirsch Kupfer- und Messingwerke A.-G.

Southern Rhodesia.—The output of gold from Southern Rhodesia during October was 55,196 oz., as compared with 56,790 oz. for the previous month and 50,416 oz. for October, 1932. Other outputs for October were: Silver, 10,453 oz.; coal, 54,560 tons; chrome ore, 6,172 tons; asbestos, 1,684 tons; mica, 852 tons; iron pyrites, 1,407 tons; scheelite, 22 tons.

The report of Wankie Colliery Co. for the year to August 31 last shows a profit of £75,633, as compared with £79,461 in the previous year. After adding the sum brought in from the previous year and making allowances for taxation there was a balance of £69,082 available. A dividend of 6% absorbed £49,778, leaving £19,304 to be carried forward. During the year 474,780 tons of coal was mined, the reserves at the end of the year being estimated at 15,760,000 tons.

Northern Rhodesia.—The output of gold from Northern Rhodesia during October was 75 oz., as compared with 313 oz. for the previous month and 68 oz. for October, 1932. Other outputs for October were: Copper,

10,340 tons ; zinc, 1,680 tons ; manganese ore, 1,024 tons ; mica, 700 lb. ; cobalt, 43,075 lb.

The report of Roan Antelope Copper Mines for the three months to September 30 last show a working profit of £177,638. After allowing for debenture interest and placing £37,500 to reserve for depreciation there was a profit of £113,915.

The report of the Rhodesian Selection Trust for the year to September 30 last shows that production of copper concentrates from the Mufulira mine commenced on October 1 last, arrangements having been concluded with the Rhokana Corporation for smelting the concentrates for one year. Rhodesian Selection Trust, Rhokana Corporation, and the British South Africa Company have agreed to provide Mufulira Copper Mines, Ltd., with cash funds up to £300,000 in return for shares.

It was announced this month by Rhodesian Anglo American, Ltd., that arrangements had been concluded for the redemption of the whole of the outstanding 7¾% debentures on June 30 next at 101%, advantage having been taken of the recent dollar depreciation to redeem the whole of the American holding. To provide the necessary finance it has been decided to issue a new series of 5% 20-year sterling debentures for £750,000.

Accompanying the report of Luiri Gold Areas, Ltd., for the 15 months to June 30 last are details of a scheme of capital reorganization calculated to give the company sufficient funds to resume development of its properties in Northern Rhodesia. Under the scheme proposed the priority shareholders will relinquish their rights and their holding will rank as ordinary shares, while the 360,000 ordinary shares at present issued will be written down to 1s. and then reconsolidated into 5s. shares. At the same time it is proposed to increase the capital by the creation of 288,000 new 5s. shares, making the unissued shares 608,000, of which 192,000 will be offered to shareholders at par.

Gold Coast.—At an extraordinary meeting of the Ashanti Goldfields Corporation held this month resolutions proposing an increase in the capital of £500,000 by the creation of 2,500,000 new 4s. shares and the distribution of these as a capital bonus to existing shareholders were approved.

Good developments on Nos. 4 and 5 levels of the Bibiani mine were announced this month. On No. 4 level cross-cut No. 12 E. shows a reef width of 35 ft., averaging 20·8 dwt., while cross-cut No. 15 E. on No. 5 level shows reef over 45 ft. in width, averaging 25·7 dwt.

The accounts of Akim (1928), Ltd., for the year to September 30 last show a profit of £38,642. After making allowances for depreciation and subtracting the debit balance brought in there was £25,018 available, from which a dividend equal to 10% is to be paid.

At an extraordinary general meeting of the Consolidated African Selection Trust, held this month, it was approved that the capital be increased to £600,000 by the creation of 250,000 redeemable cumulative 6½% preference shares of £1 each and 400 new ordinary shares of 5s. each. An issue of preference shares will be made in order to finance the company's new business in Sierra Leone.

Nigeria.—During the year to June 30 last United Tin Areas of Nigeria made a profit of £3,621, reducing the debit balance to £2,398. Tin concentrates recovered for the year amounted to 121¼ tons, as compared with 189 tons for 1931–32.

Australia.—The accounts of the Wiluna Gold Corporation, which owns the Wiluna Gold Mines, show a debit balance of £100,901 on income and expenditure account during the year to March 31 last. It is intended to extinguish this by writing it off share premium account. The accounts of the operating company for the 15 months to March 31 show a profit of £268,836 (Australian), increasing the sum brought in to £307,787. Since the close of their financial year Wiluna Gold Mines has further reduced its liability on the 6% note issue to £200,000 and notice of redemption of this balance has been given to holders. During the period mentioned the company milled 426,840 tons of ore and recovered 123,085 oz. of gold, worth £909,142, arsenic sales bringing the total revenue to £911,192, while working costs were £481,447. The corporation has declared an interim dividend of 2s. per share in respect of the current year.

Dissatisfaction among the labour on the Kalgoorlie field is indicated by a decision of the Miners' Union to present an amended schedule to the Chamber of Mines and requesting a conference.

Shareholders of Associated Northern Blocks (W.A.) have been informed that an option over its Ora Banda property has been granted to the Gold Fields Australian Development Company.

The report of Mount Elliott for the year to June 30 last shows that tributing operations were continued during the year. In January last the company acquired options over several alluvial deep-lead properties in Victoria, a half-interest in which was subsequently acquired by Oroville Dredging. Preliminary exploration having proved satisfactory, the finance necessary for further development of certain of these areas is being arranged.

A cabled summary of the report of the Mount Lyell company to September 30 last shows a profit of £49,214, the net credit balance of profit and loss now standing at £111,217. During the year 403,160 tons of ore was treated, yielding 39,698 tons of concentrates, averaging 24·65% copper. Blister copper produced by the smelter amounted to 10,531 tons.

Malaya.—The report of Ayer Hitam Tin Dredging for the year ended June 30 last shows a profit of £15,064, increasing the sum brought in to £24,079, of which dividends equal to 7½% absorbed £13,500 and £3,200 has been allowed for depreciation, etc., leaving £7,379 to be carried forward. The output of tin concentrate was 366·83 tons, which realized £38,191.

During the year to April 30 last the Kampar Malaya dredge was closed down pursuant to the pooling arrangement with Southern Kampar Tin Dredging. The revenue for the year was £6,336, increasing the sum brought in to £10,160. A dividend of 3d. per share absorbed £4,507, while £2,500 was placed to reserve and, after making other allowances, £3,065 was carried forward.

The registration of Ampat Tin Dredging was announced last month. The new company will amalgamate four existing companies —Batu Caves Tin, Batang Padang, Malayan Tinfields, and Tujoh Tin (N.L.), in liquidation —and will have a capital of £250,000 in 4s. shares, of which £220,000 will be issued at once for the purpose of acquiring and operating the various properties.

Colombia.—During the year to June 30 last Frontino Gold Mines made a profit of £89,506, increasing the sum brought in to £117,500, of which £54,000 has been placed to reserve and £4,171 written off development account. Debenture interest and dividends paid earlier in the year absorbed £14,098 and from the £45,231 remaining dividends equal to 11¼% on the ordinary shares and 5% on the preference shares have been declared, absorbing £22,084, and leaving £23,147 to be carried forward. The company's main ore reserves are still concentrated in the Silencio and Marmajito mines, but other occurrences on the property are being rapidly developed.

Venezuela.—The accounts of the New Goldfields of Venezuela for the year to June 30 show a loss of £28,197, increasing the debit balance to £108,025. During the year the mill treated 108,244 tons of ore and old tailings for a recovery of 28,626 oz. of gold. The ore reserves at the end of the year were estimated to be 457,352 tons, averaging 8·8 dwt. The tramway from the Union mine was put into operation in May and the tonnage from this mine is likely now to increase.

Panama.—At a meeting of debenture-holders of the Panama Corporation, held in Montreal last month, it was agreed that their interest moratorium should be extended for a further year in order to enable the corporation to continue the development of its properties.

Sulphide Corporation.—The report of the Sulphide Corporation for the year to June 30 last shows a profit of £37,817, against a loss of £55,844 the previous year, the improved result being mainly due to the Central mine having been worked at full productive capacity.

Star Explorations.—During the year to September 30 last Star Explorations made a profit of £8,042, increasing the sum brought in to £12,005. Of this amount £9,151 has been distributed as dividends, equal to 20%, and a bonus of 2½%, £1,250 placed to reserve, and, after allowing for other items, a balance of £1,390 carried forward.

Camp Bird and Santa Gertrudis.—Shareholders of the Camp Bird and Santa Gertrudis were informed last month that in view of the absence of their chairman, Mr. F. W. Baker, in Australia, on business, it had been decided to delay the presentation of the report to June 30 last until his return.

Tin.—A further reduction of visible supplies is evidenced by the figures for the end of November, the total at 31,670 tons being down 2,130 tons on the month. At an extraordinary meeting of Tin Holdings, Ltd., to be held this month, it will be proposed that the company should go into voluntary liquidation, its tin now being in process of sale by the International Tin Pool.

PROSPECTING IN KENYA BY EARTH-AUGERING

By A. J. P. WALTER, M.Sc.

A description of systematic prospecting in the Kakamega goldfield by use of the earth-auger, together with an account of the geology of the area.

INTRODUCTION.—The rainfall in the Kakamega area of Kenya Colony is heavy, averaging about 80 in. a year. Deep secular decay of the rocks, which are predominantly argillaceous, has taken place and given rise to a thick soil mantle, limiting the outcrops to those of the harder intrusive rocks, of the silicified conglomerates, and of wide barren quartz veins. The rocks weather into a tough, sticky clay that is the bane of the alluvial worker. The lack of outcrops, the undergrowth, and the heavy overburden, which averages 8 to 10 ft. in depth and extends to 40 and 50 ft. in places, make prospecting difficult and haphazard in the extreme. Deep trenches, "gopher holes," and the inevitable adits are the usual means by which some knowledge of the underlying formation can be obtained. A great deal of earth-augering has also been done throughout the area and its systematic application has proved a cheap precursor to the extensive excavations which must of necessity follow it. The particular method and graphic interpretation of the results here described have been applied exclusively, under the writer's supervision, by two of the companies operating in the area. To date over 60,000 ft. of augering has been completed in this manner and there is hardly a hole which has failed to reveal at least a speck or two of gold.

The principle underlying the method is that a deposit carrying free gold—which, fortunately, is invariably the case in Kakamega—sheds its values throughout the overlying soil as it weathers. In other words, the auger brings up samples from the eluvial or from the residual concentration derived from the ore-body. Gravity, soil creep, drainage—all combine to give a "tail" in the soil to the deposit. The exact location may not be immediately possible, but the area further to be prospected in order to effect a discovery is considerably restricted.

FIG. 1.—ROCKER ENSEMBLE, KAKAMEGA GOLDFIELD.

The method consists of soil sampling by the use of augers, washing the soil in specially designed rockers, and estimating by eye the quantity of gold recovered from each particular hole. These values are systematically recorded and mapped, the interpretation of the results guiding the course of subsequent excavations.

The personal factor is important in the estimation of values and the absolute

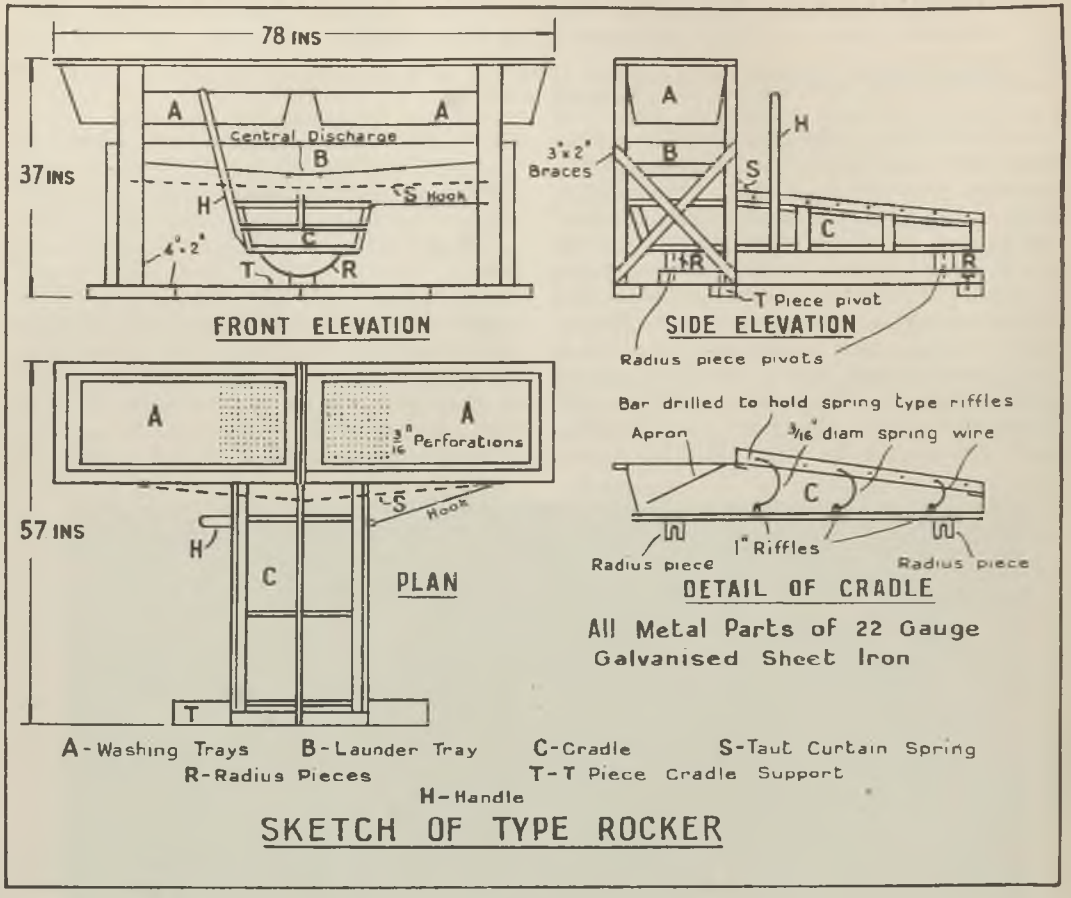


FIG. 2.

necessity of consistency was well understood by the samplers, who were given every opportunity of becoming expert at their work. They were keenly interested, jealous of the accuracy of their judgment, and there is every reason to believe that the results obtained are comparatively reliable. The values are recorded as letters: A—one or two small specks; B—three or four small or two medium specks; C—four to eight specks or a small tail of fine gold; D—eight to twelve specks or three to four large specks and a good tail of fine gold; E—any value in excess of D, and Ex—extraordinary values.

The greatest advantage to the method, apart from its relatively low cost and the rapidity with which large areas can be covered, is that it allows the prospector to "follow the gold." It is not claimed to be the *sine quâ non* of prospecting for the particular conditions that obtain in Kakamega, but merely as a precursor to excavations it has been found invaluable. A great part of the field is under cultivation and compensation must be paid for any work done in "shamba" land. Preliminary earth-augering restricts unnecessary earth excavations, minimizes the disturbances caused through the spoiling of crops, and thus reduces considerably the attendant cost of compensation.

Some exposition, however sketchy, of the geology of the area is necessary, in order better to understand the work of prospecting. The notes that follow make no attempt at correlation; they merely give the salient points observed during the examination of a large number of claims. A good deal more work is needed before a comprehensive study of the geology can be presented.

GEOLOGICAL NOTES.—The sedimentary rocks represented in the Kakamega field have been highly metamorphosed and occur in the

nature of "roof pendants." In places phyllites and conglomerates have been highly sheared and exhibit very steep dips and in others a uniform succession of conglomerates, grits, and argillites, while having been submitted to intensive thermal action, show no evidence of schistosity. It is possible and very likely that at least two series are here represented, but the presence and absence of shearing and even the extreme difference in the altitude of the steeply-dipping sheared and the relatively flat-lying unsheared rocks are insufficient evidence at this stage to justify a separate classification. As a working hypothesis the unsheared rocks have been looked upon as a younger series and referred to as the Isioko series, as they occur mostly in the Isioko drainage basin, while the steeply-dipping conglomerates, phyllites, and sheared porphyries, better exposed in the Yala river basin, were looked upon as the underlying and older Yala series. The widespread occurrence of the unsheared conglomerate and the appearance within it of gold-bearing quartz pebbles strongly favour the existence of a basal unconformity, but for the present purpose the sediments will be grouped together as a series of conglomerates, grits, phyllites, and argillites, invariably metamorphosed and sometimes highly sheared.

Two main periods of mineralization at least, may be postulated, since pebbles of gold-bearing quartz veins can be found in the conglomerate. Two major types of plutonic rocks have been recognized—

(*a*) The granite that has its main occurrence north of the Bakuru ridge—the watershed of the Yala and Isioko drainages—and extends northwards past the Kakamega township towards the Nandi escarpment along the Broderick Falls road. This may be referred to as the Kakamega granite.

(*b*) The Maragoli intrusive, which seems to be more of a monzonite than a granite, occurring mainly south of the Yala and extending into the Maragoli territory.

The Kakamega granite is remarkable for its marginal basic differentiates. From a point along the Kaimosi–Kakamega road near the Friends' African Mission, where the Isioko basal conglomerate can be seen in contact with a chilled, highly basic marginal edge of this granite, due west, the intrusive rocks can be traced through a series, gradually increasing in acidity, to the coarse porphyritic granite itself, within less than 5,000 ft. A remarkably interesting study beckons here to the petrologist.

The Maragoli monzonite is coarsely porphyritic. The felspar is invariably twinned in the Baveno or Carlsbad mode and is characterized by zonal growth. It is associated with pegmatites carrying black tourmaline and the presence of cassiterite has more than once been suspected.

Porphyritic dykes are common and have sometimes been sheared in conjunction with the rocks they intruded. The general

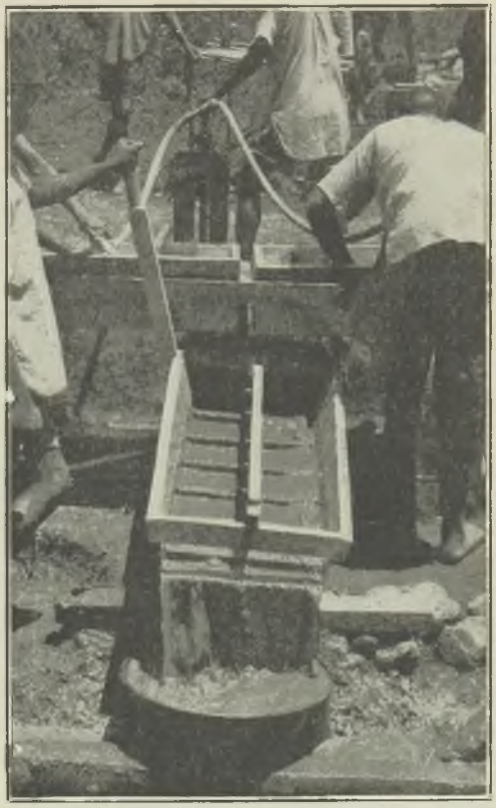


FIG. 3.—CLOSE VIEW OF ROCKER IN ACTION, KAKAMEGA.

strike of the series in the Yala basin is nearly E.–W. and swings to the north. The dip is steeply to the south, but further to the east and in the vicinity of the Nandi escarpment. While ore-bodies occur in the finer-grained members of the series such as the phyllites, the richest have been observed in the conglomerates, mineralized fault-planes across the latter showing high values and impregnation zones giving promise of considerable tonnage.

In the Isioko basin the sediments are represented by conglomerates, grits, and

FIG. 4.—ROCKER WITH STATIONARY TESTING SLUICE, KAKAMEGA.

argillites in uniform succession and are sometimes highly silicified. The rocks are characteristically dark green to grey in colour, the finer-grained members of the series weathering to a putty-like, clayey mass.

The series in the Isioko basin shows evidence of no stratification. The rocks are rarely sheared and remarkable for the thermal nature of the metamorphism to which they have been submitted, arising from the influence of the invading Kakamega granite. The matrix of the conglomerate and the grits has been altered and these rocks are at times difficult to distinguish when weathered from some of the basic facies of the Kakamega granite.

Examples of the conglomerate intruded by some basic phase of the granite can often be observed and in one case a low-grade ore-body has developed at the contact. The conglomerate in this instance, being in an advanced stage of disintegration, has been worked as "drift" for alluvial.

Very rich quartz pebbles have been recovered from the alluvial workings of a stream draining across a wide tract underlain by conglomerate. The quartz was at first believed to have been shed from a quartz vein higher up stream and a diligent search was made for the source of the gold, as the pebbles assayed 8 to 10 oz. to the ton. Intensive earth-augering and trenching failed to reveal the presence of any such rich vein. The peculiar rounded shape of the quartz pebbles and the unusual nature of the mineralization—fine free gold in pale, white, sugary quartz, not known to exist in places anywhere in the thoroughly prospected vicinity—led to the belief that the quartz was derived from the conglomerate and was one of the constituent pebbles of the rock. While unimportant economically, it is interesting to note that the conglomerate can be suspected of being of fluviatile or even aqueo-glacial origin. The pebbles are unsorted and often faceted or grooved.

Folding is not obvious from localized study. Sir Albert Kitson says in his interim report

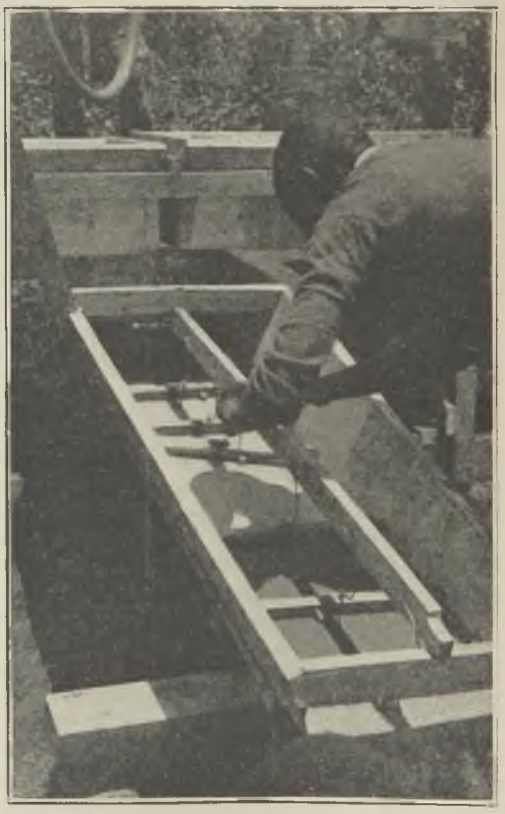


FIG. 5.—SETTING RIFFLES IN ROCKER, KAKAMEGA.

on the area—"These rocks appear to be folded into at least two synclines and two anticlines, with a general strike of about E.–W." It is not intensive and is unlikely to be closely related to ore deposition. Fracturing, on the other hand, seems to be general—slickenslides, indicating relative movement between fracture blocks, are extremely frequent. From the little that is known of the tectonics, one is led to believe that block-faulting is common and may be proved in time to have been a strong controlling factor of the mineralization.

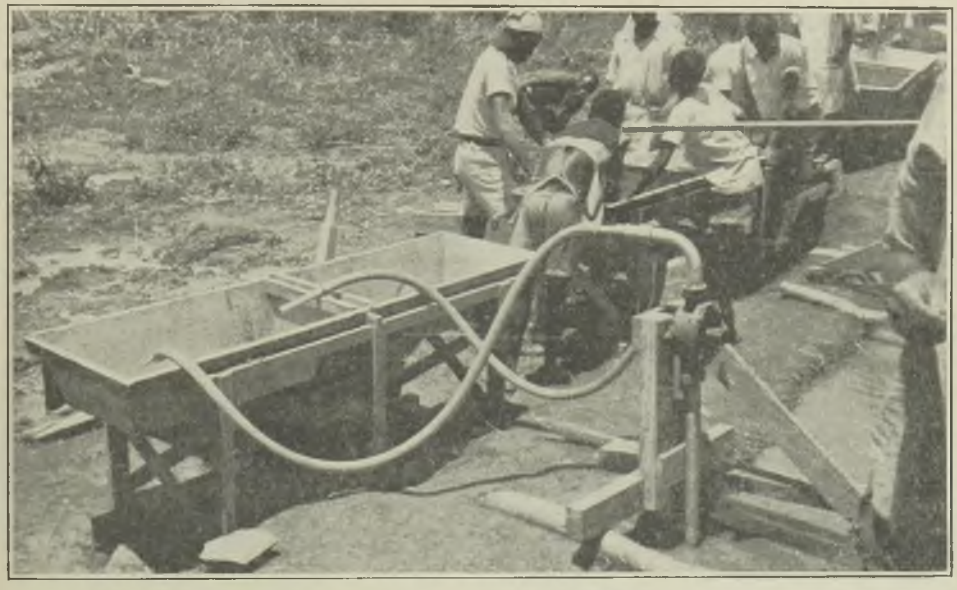


Fig. 6.—Washing Trays and Pump, Kakamega.

The ore deposits may be broadly classified as—

(1) Gold in association with quartz in quartz veins, with little or no impregnation of the adjoining walls.

(2) Mineralization along fault-planes, with considerable metasomatic replacement of the wall rock, but associated with little or no vein quartz.

(3) Contact deposits—gold associated with considerable pyrite and arsenopyrite.

(4) Mineralized dykes, with wall rock impregnations.

(5) Highly-oxidized leached sulphide lodes, usually along fault-planes and manifested at the surface as gossans.

The types of vein quartz are numerous and indicative of frequent magmatic regeneration. The large white quartz veins, so frequently encountered along the Broderick Falls road, N.W. from Kakamega, are invariably barren. The blue-white glassy quartz veins striking approximately E.–W. in the vicinity of the Bakuru ridge may in some cases prove to be mineable. They are invariably of very low grade, but their persistent strike and promise of large tonnages warrants their close examination.

The richest quartz veins invariably strike approximately N.–S. and some seem to have been fed from the main Bakuru ridge dyke, which extends westward from Piccadilly Circus along the Butere road for a considerable distance. Wall rock impregnation is often associated with these veins. Some rich brecciated veins of quartz with fine-grained black tourmaline occur within the Kakamega granite, about four miles south of the Isioko river and a little west of the road to Kaimosi. There is little hope of big tonnages from the high-grade quartz veins, but as the values are often so high some may prove to be valuable ore-bodies.

Mineralized fault-planes are likely to prove the most valuable deposits of the field. It seems that in this instance, too, the N.–S. faults tend to rich values, while the intersecting E.–W. ones are associated with a considerably lower grade of mineralization. These ore-bodies are usually almost devoid of vein filling, although the country on either

side of the fault-plane may be silicified. They have given rise to coarse crystalline gold, especially where they occur in the conglomerates. The biggest nuggets of the field have undoubtedly been derived from such deposits. The shape and general occurrence of such gold is reminiscent of the native copper of the Keewanaw Peninsular on Lake Superior.

Some sulphide replacement deposits are known and as often as not occur in the conglomerate of the Isioko series. They are likely to be of low grade, but may yield a considerable tonnage. In some cases the pebbles of the conglomerate have been completely replaced. The arsenopyrite can be readily detected by the peculiar odour of garlic noticeable on hammering the ore.

A small basic dyke, about 4 in. to 6 in. wide, rich in pyrite carrying about 24 dwt. of gold, runs through a low-grade ore-body in conglomerate. Values extend as much as 10 ft. on either side of the dyke. This type of deposit has only been observed once, but there is reason to believe that some basic dykes have been silicified and enriched and may in time prove to be valuable ore-bodies.

Several gossans, from 4 ft. to 6 ft. in width—lodes completely leached out to the water-level—have been known to carry low values, but none, as far as is known to date, has proved to be workable. The outcrops of these often have the appearance of clinkers.

The conglomerate is still the puzzle of the field. There is still hope that deposits of considerable tonnage will be found within it, as it is invariably seen to be silicified and mineralized with sulphides, to a greater or less degree, wherever it outcrops. It very often carries low values of $\frac{1}{2}$ to 1 dwt.

Nature has been prolific in the Kakamega area—too prolific, perhaps—as gold occurs almost everywhere in greater or less quantities within this field, which covers nearly 420 sq. miles, as estimated by Sir Albert Kitson in his interim report on the area. It is too early yet to talk of paragenesis. Few deposits have been opened up below water-level and weathering has been intense, but the field is remarkable for the number of deposits in which gold seems to be so little associated with other metallic minerals. The silver content rarely exceeds 12%.

Prospecting.—The unusual conditions of high humidity, of easily-disintegrated rocks and ore-bodies, and the consequent scarcity of outcrops called for unusual methods of prospecting. Earth-augering arose out of sheer necessity, not to mention the strong agrarian influence in the field. It finds its readiest application and gives the best results in the case of deposits such as impregnation zones along fault-planes and contacts which give no surface indication of their existence. The resistant quartz bodies, perhaps due to the shallow depth of the soil in their vicinity, give very erratic graphic results, but as these invariably outcrop somewhere along their strike they may be discovered by diligent search.

The usual procedure in prospecting a block of claims by earth-augering is first to follow the boundary lines and, if possible, to determine the general strike of the formation; then to blaze parallel lines about 200 ft. apart, as far as possible at right angles to

Table 1

Drilling Schedule

Name of Driller .....
Date.....
Reference .....
Depth of Hole .....
Depth of Float .....
Diam. of Hole .....
Soil.....
Bedrock.....
Water Level .....
No. of Debies .....
Notes :

Table 2

Work Sheet

Name of Driller	Reference	Depth	Dist. from Base Line	Float			Conc.		No. of Holes	Footage per Driller	Total Footage
				WT.	Index	Assay	Index	Assay			

the strike, and to map all outcrops and occurrences of float along these blazed lines.

The position of the rockers is selected and should be such as to minimize the distance the spoil from the augers has to be carried before being washed. Fortunately there is little difficulty in finding sufficient water for the operation of the rockers.

Augering.—The augers used were the ordinary standard post-hole augers, 8 in. in diameter. This size was found to be the most convenient, as it gives a sample of adequate bulk, permits the recovery of reasonably good-sized rock-float from the hole, and is not unduly slow in operation, not to mention the fact that it was about the only one to be had in the Colony.

These augers were not made to penetrate to any great depth and, as some of the holes had to be sunk to as much as 50 ft., extension rods had to be designed. Those in general use in the field are made from 4-ft. lengths of 1-in. diameter iron piping. They are attached to the auger and to each other by sleeve joints held together by transverse loosely-fitting $\frac{1}{4}$-in. bolts. The nut holding the bolt is lightly tightened by hand. If the cutting edges are kept sharp and the blades are properly adjusted, the augers are easy to operate in the soft, moist soil of the district. No downward pressure on the auger should be needed during its rotation. It is sometimes, but rarely, necessary to pour water down the hole to facilitate the cutting if the ground has dried up and hardened.

The holes are spaced 50 to 100 ft. apart along the blazed traverse lines. One European supervises the operation of three augers and records the field notes on special drilling schedules—one to each hole. Two boys are used per auger for the actual drilling, resting and working alternately. Five to seven boys more, depending on the distance the spoil has to be carried to the rockers, completes the crew needed per auger. The auger is pulled up when full and its contents are shaken into old petrol tins. A full tin holds the spoil from 1 ft. of hole drilled. As the hole deepens extensions are added to the rod and the drilling is continued until the hardening rock precludes further progress.

Fig. 7.—Pump Feeding Rocker, Kakamega.

Fragments of bed-rock were usually obtained sufficiently undecomposed to give an idea of the composition of the underlying formation and changes of formation from one hole to another were immediately noticeable, in spite of the fact that the surface soil gave no indication to that effect. Information of this description makes it possible to compile a geological map as the augering progresses.

Each petrol tin, when full, carries a label identifying it for the line, hole, and depth from which its contents came and is sent to the rockers. It was decided, after experiment, that the entire spoil from each auger-

hole should be washed, as the distribution of the values in relation to depth was very erratic, the gold having probably settled according to Stokes' law. Washing sections of each hole at a time was found to be far too slow and laborious a process to be possible even if desirable.

Rockers.—Some essential requirements had to be kept in mind while designing a suitable rocker [1]—

(1) Freedom from any likely gold traps in the washing parts, so as to preclude any possibility of salting.

(2) Accessibility and simplicity of all parts to permit of quick cleaning between the treatment of each separate sample.

(3) Provision for thorough mixing and breaking up of the clayey soil, in order to liberate its gold contents.

To meet these requirements the unit was built entirely of galvanized sheet-iron mounted on wood; all seams and rivets were covered with a smooth surface of solder.

The soil is thoroughly puddled with water in two stationary washing trays perforated by $\frac{3}{16}$-in. holes spaced 1 in. apart. This ensures its complete disintegration. These trays are mounted on a rigid rectangular wooden framework and are easily removable. A lower tray fixed to the framework receives the pulp from the washing trays and discharges centrally on to the apron of the rocking cradle immediately below it. The cradle itself rests on a T piece made of wood and rocks on two iron pins that fit into two semi-circular wooden rollers or radius pieces beneath the cradle. The T piece is made of wood and is loosely held by an iron pin to the lower front member of the framework supporting the trays and allows the cradle it supports to be adjusted for slope and direction by virtue of its motion about the pin.

The riffles had to be quickly and easily removable and the method of attaching them to the cradle had again to be such as to preclude all possibility of salting. This was met by holding them against the floor of the rocker by semi-circular hoops of brass spring wire $\frac{3}{16}$ in. in diameter, hinged at one end to the middle of the riffle and hooked in compression, at a point vertically above the riffle, to a wooden arm extending down the top middle length of the cradle. The ends of the riffles were fitted with strips of rubber held in a vertical saw slit. The rubber was stretched thin, inserted into the slit, released and trimmed so as to allow about $\frac{1}{4}$ in. to protrude from the end of the riffle. This made a very effective joint between the side-walls of the cradle and the end of the riffles.

At first as many as six 1 in.-high riffles were used, but it was found eventually that three riffles were adequate and corduroy, which was originally stretched between the last two riffles, was also discarded.

The rocking arm of the cradle is fastened by two stretched curtain-springs to the frame on which the washing trays are erected. It was found that the springs steady the rocker, whose motion their tension regulates.

Washing.—The tins of spoil coming from each auger-hole are grouped together, to await washing, near the rocker allocated to the particular hole from which the tins were filled. The soil is fed by hand into the washing trays and the tins are cleaned and returned to the augers. Water is added to the trays by 1-in. hand-operated semi-rotary pumps, drawing from temporary mud dams across the stream or from ditches near which the rockers are erected. A boy stationed at each washing tray thoroughly puddles the clayey soil and regulates the flow of water, so that pulp of the right consistency should be fed to the cradle. The greatest difficulty is to ensure the effective breaking up of the clay, as nodules of this material in the rockers carry away much of the fine gold. The slope of the cradle varies between 1 in 8 and 1 in 12, depending on the nature of the soil.

The quartz or rock-float caught in the washing trays is carefully washed and its nature noted. It is then crushed and

[1] The author's thanks are due to Major G. L. O. Grundy, who constructed the first rocker of this type, for much advice and assistance in the designing.

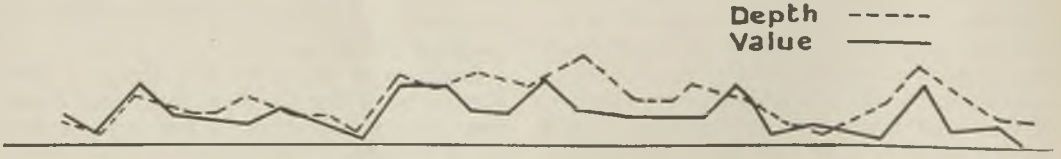


Fig. 8.—Curves Showing Typical Apparent Relation between Depth and Lower Values.

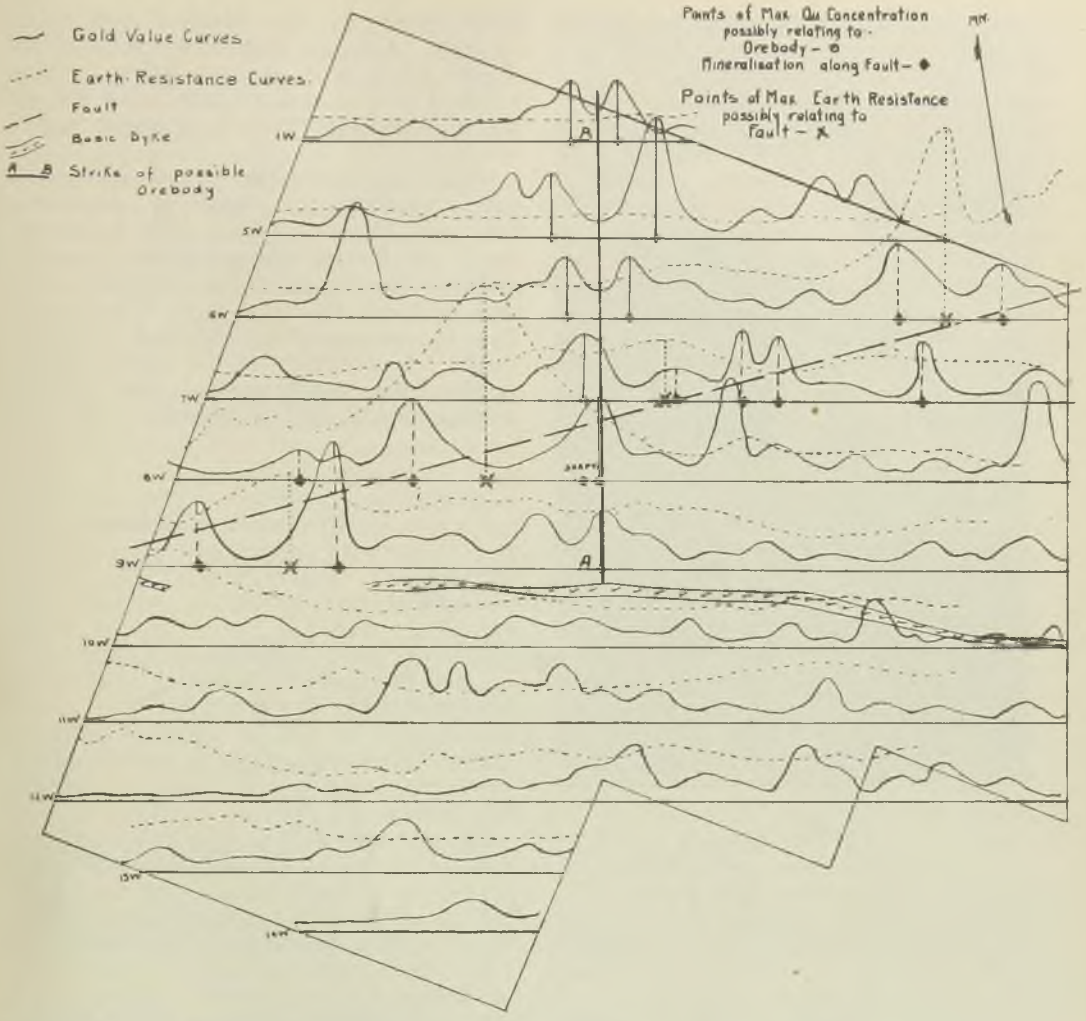


Fig. 9.—Depth and Value Curves Relating to an Earth-Auger Traverse.

panned. These values are recorded separately from the values caught by the riffles.

When all the soil from one hole has been washed the rocking is stopped and the cradle locked in a level position by a hook attached to the framework. The water supply is cut down to a quantity just sufficient to permit the concentrates to be washed out of the cradle. A clean pan is placed at the discharge end and one by one the riffles are knocked out, starting from the lower end of the cradle, and the concentrates carefully washed into the pan. The concentrates are then panned by hand and their free gold content estimated.

A small stationary sluice-box every now and then is erected in turn beneath each rocker to test its efficiency. On rare occasions a speck or two of gold is caught by the sluice and it can be claimed that the rockers, properly erected, are capable of the most unexpected efficiency, in spite of the clayey nature of the soil.

All observations and results obtained during the washing are entered on a special rocker schedule. The joint information on the drill and rocker schedules relating to a particular hole are entered on a daily work-sheet, from which maps and curves are drawn.

A European operator in charge of a set of six to eight rockers is responsible for their adjustment and effective operation. He may also have several "askaries" or "karanies"

to assist him. The crew needed per rocker consists of five boys—one pump boy, two washing boys or puddlers, one boy operating the rocking arm, and one panner. One rocker will serve two augers and an auger will drill at least 60 ft. per shift. A much higher rate of progress is possible if the holes are not too deep and if the drilling and washing crews are well trained.

Maps and Curves.—The information collected from the auger surveys is mapped and this map gives the position of the traverse lines and of the holes. The following system was used by the author :—At the hole site on the plan a letter below line was used to signify the gold value in soil, while a letter above the line signified gold value in float. A figure above the line signified depth of hole in ft., a figure below the line signified number of auger hole, and a dot on centre of line signified 8-in. diameter auger-hole.

Curves are then drawn to scale on section paper showing—(1) depth of successive holes and (2) gold values from successive holes. At first arbitrary numbers in arithmetic progression, plotted to a suitable scale, such as A = 5, B = 10, C = 15, D = 20, and E = 25 were used to represent the gold values. A correction for the varying depth of the holes was attempted, but it soon became evident that to establish a definite

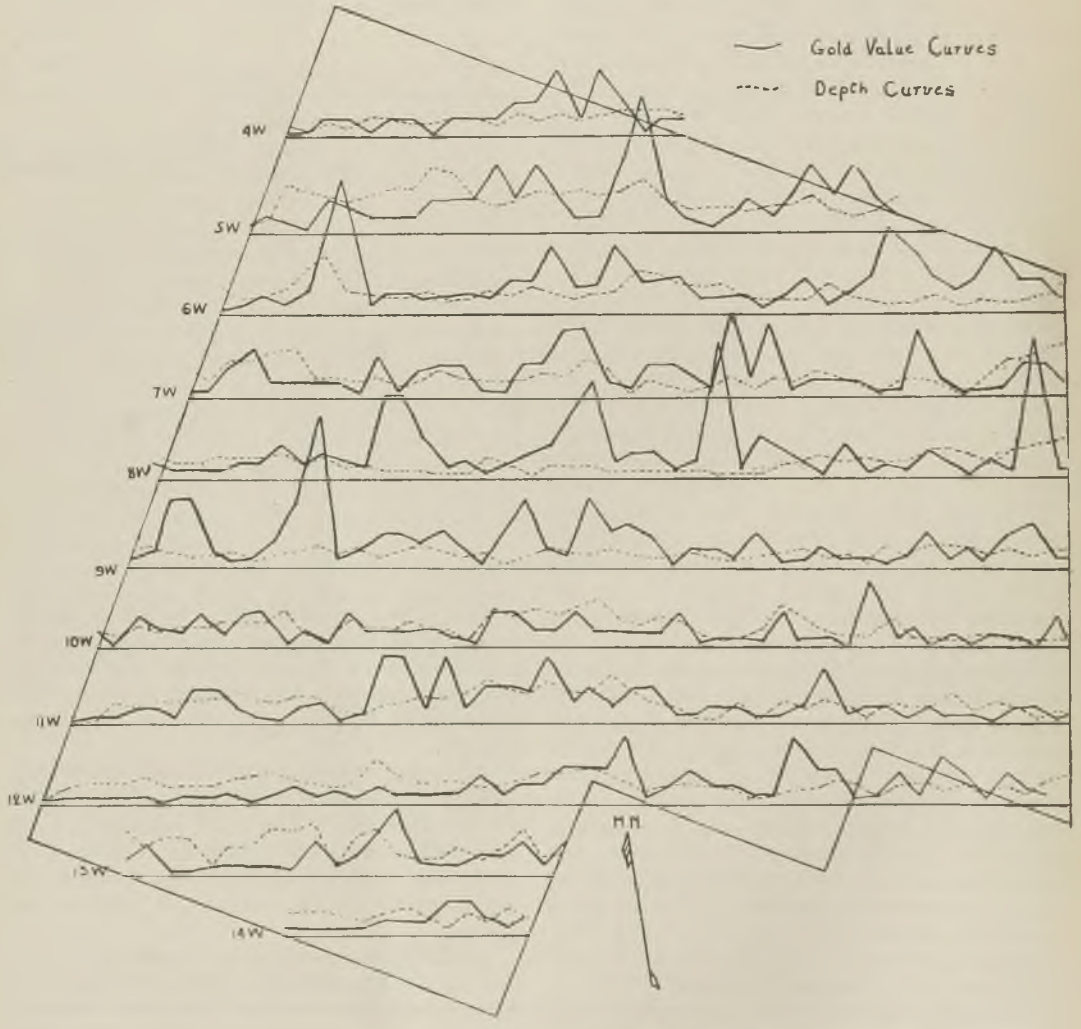


Fig. 10.—Smoothed Value Curves and Superimposed Relative Earth-Resistance Curves.

correlation between depth and values was not possible, as so many unknown variables enter into the equation and as the values themselves are only relative.

The comparison of a large number of related depth and value curves does point to the existence of a low soil constant, as the two curves rise and fall in sympathy. In the vicinity of a source of gold, however, the divergence between the two curves is so pronounced that the effect of depth may be completely neglected without seriously affecting the graphic evidence of gold concentration.

If the arbitrary alphabetic scale used to represent the values is closely examined it will be noticed that the progression from letter to letter is more geometric than arithmetic and it has been found that the curves plotted on a geometric progressional scale give the best graphic representation of the rise and fall of values. This method of plotting has been adopted and the effect of depth is completely neglected. A series of actual depth and value curves, the latter plotted to a geometric progressional scale, so that A = 1, B = 2, C = 4, D = 8, E = 16, and Ex = 32 is shown in Fig. 9. The values obtained from the float and from the soil coming from any one particular hole have been added and plotted to represent the total value of gold derived from that hole.

The data for these curves are taken from an actual survey and Fig. 10 shows the smoothed-value curves in comparison with earth-resistance curves obtained by a Megger earth-tester over the same traverses followed by the augers. The trace of the fault-plane shown across Fig. 9 is the assumed extension of the strike of a known fault identified at a point 1,000 ft. to the east. The earth-resistance curves seem to justify this assumption, as is shown by the grouping of points of high resistance along the strike of the fault.

TABLE 3

Rocker Schedule

Name .....

Date.....

Reference .....

No. of Debies .....

Spoil Conc. .....

Float Conc. .....

Notes:

FIG. 11.—COLLECTING CONCENTRATES FROM ROCKER CRADLE, KAKAMEGA.

The points of maximum gold concentration on the traverse lines indicate the possibility of the existence of an ore-body striking in the direction of the line AB—Fig. 9. The latest information is that this assumption is also justified. The curves indicate that the ore-body extends as far as the dyke to the south and is later than the fault. The fault itself has given rise to an impregnation zone carrying low values. This seems also to have affected the curves, as these show points of concentration grouped roughly along the strike. An adequate explanation for the existence of unrelated peaks is not yet possible. It is sometimes worth trenching near isolated values, but " rogue " peaks are usually neglected.

Hill slopes have a marked effect on gold concentration in the soil, as the points of maximum value move down slope in proportion to the grade. An ore-body on a steep slope may give no marked indication, as most of the values have been carried down to the streams to form alluvial deposits.

Conclusion.—There can be little doubt that earth-augering will soon be followed by the extensive use of geophysical methods of prospecting on the field. The use of the standard "Megger" earth-tester, in conjunction with earth-augering, has indicated the presence of structures barely suspected. It has given the best results in tracing the extensions of faults. The earth-resistance curves shown on Fig. 10 were plotted from readings obtained by this instrument, using four electrodes at 50-ft. spacings.

The actual specific cost of an operation is shown in Table 4.

Table 4

Area	8 claims, 143 acres.
No. of augers	6
No. of rockers	4
Average daily native strength	75
European supervisors	3
Interval between holes	50 ft.
Time taken	19 days.
Total costs	Shs. 1585.
Cost per acre	Shs. 11·08.

Shs. 5·00 per acre is a fair average over a

Fig. 12.—Six Rockers in Operation on Kakamega Goldfield.

The results obtained by earth-augering being purely empirical, a considerable amount of experience is necessary for their best interpretation. Subsequent excavations are helping to standardize the method. The use of augers specially designed for deep drilling—and these are on the market, though not yet obtainable in the Colony—would speed up the work considerably. Their cost would be higher, as the price of the augers in present use, complete with extensions, does not exceed Shs. 30 to Shs. 40 per auger.

With better mechanical washing a greater uniformity of results would obtain, but the cost as compared with the present method would also be considerably higher. The first rocker constructed, equipped with pump and hoses, cost about £10; the cost of the equipment has now been appreciably lowered.

number of prospects when the holes are placed 100 ft. apart.

A quantitative and accurate determination of the gold recovered would be far preferable to the present method of visual estimation, but at the time that the method was initiated there was only one assay office in the field and the facilities available did not permit more accurate work. Amalgamation, burning off of the mercury, and weighing the gold was tried as a treatment for the E-value concentrates, but this was found at the time to be a process too slow and laborious to be generally adopted.

There is no reason why the method should not be perfected, as it is in general use as here described by one large company for the preliminary examination of all property bought or optioned by them in the field.

It is faster and cheaper than exclusive hand panning and introduces fewer personal errors and requires less supervision. It can be said with confidence that where uniformly negative or very poor results are obtained there is little hope that a workable deposit will be discovered. At its worst, when employed in an area where a rich concealed ore-body does exist, even if the values cannot be correlated so as to disclose the exact location of the deposit, the subsequent work needed to reveal this ore-body can be restricted to those parts of the area where the high values have been found.

STRENGTHENING DAM FOUNDATIONS

By J. ROVITI

A description of the diamond-drilling and grouting operations carried out in the course of constructing the Marathon dam for the Athens, Piraeus, and Environs Water Supply Works.

The diamond core-drilling and grouting operations described in the present article form part of the programme carried out by Messrs. Ulen & Co., of New York, during the construction of the Marathon dam, built for the Athens, Piraeus, and Environs Water Supply Works in the years 1925–1931. The desire of the constructors to provide for the greatest possible safety of the dam called for the application of special construction methods, among which the most important was that of the extensive grouting of the entire area upon which the dam was erected. For this purpose the following three distinct methods were employed :—

(1) General grouting over the entire area of the excavated ground, usually carried out by injections of liquid grout into pipes embedded either in the crevices disclosed during the excavation or into holes drilled by hand or compressed-air jack-hammers. The depth of the holes drilled by jack-hammers seldom exceeded 10 ft. and the diameter of the pipes was usually $1\frac{1}{2}$ in. Owing to the comparatively small depth of these holes and in order to prevent uplifting of the ground the pressure under which the grout was injected was not allowed to exceed 15 lb. per sq. in.

(2) Grouting under the core wall of the dam, carried out through 2-in. iron pipes embedded in holes drilled by means of compressed-air driven rotary-percussion drills. These holes were drilled to a depth of 45 ft. from the top of the first layer of concrete foundation cast into the excavated area. The thickness of this layer being equal to about 18·25 ft., it follows that, practically speaking, one half of the total depth of each hole was drilled through the concrete structure, whilst the other was continued through the sub-foundation rock. The depth of these holes being considerably larger (45 ft.) the final pressure employed for injecting the grout was carried up to 40–45 lb. per sq. in.

(3) Deep grouting in front of the entire upstream face of the dam and across the spillway, carried out through holes drilled with diamond core-drills. The diameter of these holes was $1\frac{3}{16}$ in. and the average depth of each finished hole was 181·41 ft., the total performance per hole (reaming, case reaming, and re-drilling included) being equal to 229·52 ft.

The entire diamond-drilling performance consisted of drilling 197 holes of a total depth equal to 45,215·5 ft. In grouting the injection pressures used ranged, according to the specific requirements, conditions, and depths of each hole, from 10 to 95 lb. per sq. in.

The work carried out during the construction of the Marathon dam is shown in Tables 1 and 2, where the indicated depths are the depths of finished holes. From the figures given in these tables, after making the necessary allowances for material wasted during the process of grouting and for the amounts of grout washed out of the holes when further drilling was done, it is possible to determine approximately the total volume of the crevices filled with grout. The grout being usually composed of one part of cement mixed in two parts of water (by volume), the volume of one bag of cement being approximately equal to 0·04 of a cubic metre and the amount of the grout actually injected into each hole being equal to about 88·5% of the total, we find that—

	Cub. m.
The volume of crevices filled by shallow grouting = 31,172 × 3 × 0·04 × 0·885	= 3,310·46
The volume of crevices filled by deep grouting = 20,518 × 3 × 0·04 × 0·885	= 2,179·01
Total volume of crevices filled with grout	= 5,489·47

TABLE 1

HOLES DRILLED

No. of Holes.	Type of Drilling.	Total Depth Drilled (Finished Hole). Feet.	Metres.	Average Depth per Hole. Feet.	Metres.
270	Pipes in crevices	—	—	—	—
58	Hand-drill holes	1,344·80	410·00	23·186	7·069
1,079	Waugh-drill holes	30,803·50	9,421·80	28·660	8·732
197	Diamond-drill holes	35,707·25	10,854·93	181·410	55·250

TABLE 2

MATERIALS INJECTED

Number and Description of Drilled Holes.		Amount of Materials Injected. No. of Bags. Santorene Cement.	Earth.	Sand.	Total No. of Bags.	Average No. of Bags per Hole.
1,079	Waugh-drill holes	—	—	—	—	—
58	Hand-drill holes	29,754	525	893	31,172	21·7
270	Pipes in crevices	—	—	—	—	—
182	Diamond-drill holes	20,363·5	154·5	—	20,518	112·7

NOTES.—(*a*) The depth of 58 hand-holes includes the depth of holes drilled with jack-hammers.
(*b*) Out of 197 diamond-drilled holes only 182 are considered as properly grouted.

The total volume of solid materials used for the construction of the Marathon dam being equal to 15,000 cub. m. approximately, it follows that the volume of the sub-foundation crevices filled with grout amounts to about 36% of the total mass of the dam. These figures show that the grouting programme is probably the most extensive that has ever been undertaken under a gravity dam. It will also be noticed that about 53% of the entire drilling performed for the purpose was done by means of diamond core-drills.

The object of such extensive grouting had two main purposes—

(1) To prevent uplift pressure under the dam.

(2) To prevent large losses of water through leaks under the foundations.

The execution of such a costly and complicated piece of work is fully justified by the results obtained, for the dam, after its completion, presents an absolutely dry downstream face, being free from any underground leaks even when the level of the reservoir water is at its highest elevation.

DIAMOND CORE-DRILLING AND GROUTING.—In order to prevent the possibility and the destructive consequences of the reservoir water leaking under the sub-foundations of the dam, 197 diamond core-drilled holes were sunk along the entire upstream face of the dam at intervals ranging from 1·5 to 4 metres apart, and at a distance of about 0·5 of a metre from the toe of the dam. These holes were also driven across the spillway weir, across the spillway and its retaining wall, and were ended in the limestone rock bank forming the southern abutment of the dam bridge, leading to the dam over the spillway.

The object of sinking these holes was chiefly to inject grout into the fissures encountered in the course of drilling a hole in the rock formation. The presence of such a fissure was usually disclosed by a loss of a certain amount of wash water, a complete or partial loss showing the magnitude of the fissure. Incidentally, the cores, which were removed every 10 ft., gave an idea of the formation of the sub-foundation ground through which the hole was drilled, a broken-up structure of rusty appearance invariably indicating almost exactly the depth at which a water-carrying fissure was encountered.

Almost all the holes were driven to a depth of 180 to 200 ft. from the surface of the ground by means of two Sullivan 'Turbinair' diamond core-drills (size A), operated, according to the location of the holes, from either platforms built on land or from specially arranged scows (barges) floating on the lake and conveniently fastened to the face of the dam. The drilling operations were started before water was allowed to collect behind the dam and at this time the drills were operated from platforms. Later on, as the construction of the dam proceeded, water was collected in the reservoir and, before the drilling work had been completed, the reservoir was filled up to the spillway level, so that all the holes, spaced over the ground covered by the reservoir water, had to be drilled from the scows.

The diameter of the holes drilled was $1\frac{13}{16}$ in. and the diameter of the cores removed $1\frac{1}{8}$ in., the entire drilling in the rock being

performed with drilling-bits set with Patrick blunt-edge Brazilian black diamonds. Exceptionally, when cautious drilling was necessary —as, for instance, when starting a new hole under water, or when the condition of the bottom was suspicious owing to the possible presence of abandoned timber with iron nails, iron plate washers, or drill-steel, etc., or when the presence of foreign bodies in the hole itself was suspected—artificial diamonds in the form of cubes ($\frac{13}{16}$ in. side), known as Sulamite and Widia, were used instead of real diamonds. The artificial diamonds being

Out of 197 holes drilled only 182 may be considered as being spaced along the line, holes 1 to 4 being drilled as test holes in the toe of the dam, while the 5 to 15, although correctly spaced and drilled, had to be considered as cancelled on account of their being left ungrouted due to a sudden flood by which they were covered on January 12, 1929. The total stretch of ground covered by the 182 holes was 343 metres in length, the average space between each hole thus being 1·885 metres. Actually, along the entire stretch of ground lying south of the middle

FIG. 1.—VIEW OF THE MARATHON DAM, SHOWING DRILLS AT WORK ON THE BANK AND ON THE LAKE BED. A scow anchored off the centre of the dam is unloading red clay to form a blanket along the upstream face.

very brittle and the ground drilled being very hard and broken, only short runs of no more than from 1 to 5 ft. were drilled with drilling bits set with such cubes.

Reaming the first 16 to 18 ft. of each hole, enlarging the diameter of the hole from $1\frac{13}{16}$ in. to $2\frac{3}{8}$ in., so as to allow for a 2-in. casing, was usually done with special reaming bits set with artificial diamond cubes entirely, the use of black diamonds being considered as liable to involve heavy losses. For some time black diamond chunks of practically no drilling value were set in reaming bits together with the Sulamite or Widia cubes but, losses by tear of such chunks being very heavy, this practice was entirely abandoned, notwithstanding the fact that considerably higher reaming speeds could be attained with reaming bits so set.

of the dam the holes were spaced at distances ranging from 1·2 to 1·5 metres one from the other, the ground over this part being very broken up and the fissures encountered more numerous. In consequence the total amount of grout injected was necessarily larger. On the other hand, all holes drilled along the line lying to the north of the middle of the dam were spaced at distances ranging from 2 to 4 metres, the ground over this distance being solid.

The rock consisted mainly of mica schist of greenish colour (Atick schist). The shallower ground was often brown, frequently broken up by sand and clay-bearing seams, while lower down the rock was a hard green schist containing fine quartz grains and very frequently broken up by quartz bands, the thickness of which varied from a few inches

to several feet. It might be said that 65% of the drilled ground was hard and 35% soft.

Complete reports, in which statements of the progress, nature of the ground, description of the cores removed, depths at which water-bearing fissures were found, amount of water lost, time spent in various operations, depths of casings used, wear of diamonds, etc., were made each day, while sectional coloured diagrams of each hole, showing the nature of the ground, the particular depths at which leaks were noted and groutings made, the amounts of water lost and amounts of grout injected, etc., were made and regularly consulted during the entire period of the drilling operations. All cores extracted have been carefully preserved.

Drilling operations started on May 15, 1928, and on April 11, 1929, a second machine was put into operation, both machines working from that day up to the end of June, 1931. During the greater part of the time drilling proceeded day and night and was carried out by a crew of one driller and two helpers, all locally-trained, who worked in two 12-hour shifts. Apart from the drilling crew, a grouting gang, consisting of eight men under a foreman, was always under the orders of the drilling department for grouting purposes as well as for help in transferring drill rigs to new sites when working on land or helping to drive the casings and pilot pipes when the drills were operated from scows.

The operation of the drills from land platforms was simple enough. The hole was usually started with a jack-hammer equipped with a 3-in. rose bit, by means of which 2–3 ft. of hole was driven. Into this hole a short $2\frac{1}{2}$-in. pilot pipe was inserted and temporarily grouted, when the hole was further drilled to a depth of $17\frac{1}{2}$ to $18\frac{1}{2}$ ft. by means of a standard size diamond-set bit. This part of the hole was then case reamed for a depth of 16 or 17 ft. in order to allow a 2-in. casing pipe to be inserted and grouted in. Through this pipe, which was eventually left embedded, all groutings of fissures and cavings encountered in the course of drilling at various depths were executed.

The operation of the drills from scows required rather complicated manœuvring, inasmuch as the holes had to be started under water, which at the middle of the dam was up to 160 ft. deep. The scows were fastened to the face of the dam at a given station by means of ropes and pulley blocks. The blocks on the scow were fastened by wire rope slings, while those on the dam were hooked to eye-bolts, cemented in the face. A floating raft, one side rigidly fastened to the front of the scow, was interposed between the scow and the face in order to obtain the necessary offset of the centre of the hole to be drilled from the line formed by the toe of the dam. After the scow had been fixed the depth of water from the top of the deck to the bottom of the reservoir was measured and a corresponding length of ordinary (Continental) threaded 4-in. iron pipe was lowered to the bottom. Its top end, centred with the drill chuck, was suitably clamped to the scow deck. This 4-in. pipe served as a pilot pipe for the subsequent operations.

Having centred the pilot pipe with the chuck, a length of $3\frac{1}{4}$-in. boiler flush-joint square-threaded pipe, bearing on its lower end a drive shoe and on its upper end a drive cap, was lowered inside the 4-in. pilot pipe until the shoe reached the bottom, whereupon the pipe was driven into the ground by means of a drive block operated by the turbo-hoist of the drill. The driving of this pipe into the ground continued until hard rock was encountered, short pieces of pipe being added at the top as the pipe was sunk lower. This operation ended by centring the pipe with the chuck and by clamping the pipe to the scow deck, allowing the pipe to project slightly out of the 4-in. pilot pipe. In this way the centre of the hole to be driven was fixed and a return of wash water assured for future operations.

This completed, a $2\frac{1}{2}$-in. fish-tail bit was lowered inside the $3\frac{1}{4}$-in. standpipe and a preliminary boring of the hole was started by slowly rotating the machine and simultaneously washing out all mud and other foreign matter that could be present in the hole with wash water sent through the drill-rods. As soon as the fish-tail struck hard rock and no further progress was possible it was withdrawn and a regular drilling bit of $1\frac{13}{16}$ in. in diameter, set with artificial diamond cubes, was lowered to the bottom of the hole. After having drilled several feet of regular size hole it was pulled out and the core and condition of the bit carefully examined. Should there be no indications of any suspicious matter in the form of nails or other hard substances being present in the hole and that there is nothing liable to damage the diamonds a standard size ($1\frac{13}{16}$ in.) diamond bit is lowered into the hole and the drilling continued to a depth of about 18 or 19 feet from the surface.

The next operation consisted in reaming

out 17½ to 18½ ft. of the hole with a 2⅜-in. reaming bit, set with artificial diamond cubes. On completing this operation the flush-joint boiler tube standpipe (3¼ in.) was withdrawn entirely and the hole thoroughly washed out by lowering ordinary ¾-in. iron pipes, through which water is pumped from above. Then ordinary 2-in. iron casing is lowered inside the 4-in. pilot pipe so that the first length of pipe (18 or 19 ft. long) is entirely embedded in the reamed portion of the hole, the first pipe coupling extending out of the ground by 1, 1½, or 2 ft.

Fig. 2.—Drilling a Hole on the Spillway Retaining Wall.

This pipe coupling is usually made so that one-half of its threading (the lower) is a right-hand thread, by which it is secured to the top of the embedded casing, whilst the other half (the upper) has left-hand threads, just as all the other pipes leading to the top have left-hand threads and left-hand threaded couplings. This was done in order to insure the positive unscrewing of all the top pipes except the lowest one, which has to remain grouted in the hole after it has been completed.

Having in this way set all necessary 2-in. casing, the top end projecting out of the scow deck is suitably connected with the grouting machine by means of a 2-in. high-pressure rubber grout-hose through which thick grout is sent under sufficient pressure, causing it to squirt out and to penetrate between the walls of the reamed holes and the outer walls of the casing pipe. In order to ensure the positive penetration of grout around the casing the latter is usually lifted up for several feet and then again lowered down to the bottom several times in the course of the grouting operation. The grout is then allowed to solidify, whereupon it is cleaned out right down to the bottom of the hole by means of a fish-tail of $1\frac{25}{32}$ in. in diameter.

The hole being now absolutely watertight, the regular drilling with a diamond bit was continued until the first grouting of a leak through a fissure or of a caving portion of the hole is imposed.

The 4-in. casing (pilot pipe) remains in the position where it was originally set throughout the drilling operations, thus preventing the 2-in. casing pipe from buckling under its own weight, especially when drilling in deep water. After each grouting, however, the 4-in. pilot pipe is usually lifted for a few feet above the bottom of the reservoir upon which it rests and then is dropped down again, so as to allow any grout to run out that may have possibly collected between the inner walls of the 4-in. pipe and the outer walls of the 2-in. casing. During the grouting operations another scow, carrying a stock of cement and a screen, was arranged to be pulled alongside of the drilling scow and screened cement was passed over to the grouting machine.

Grouting was usually carried out either

to grout off a fissure or to stop a caving portion of the hole and for these purposes two distinct methods were employed. In the first case, the object being to fill the disclosed fissure with as much grout as it was possible to inject, liquid grout was usually injected through a 2-in. high-pressure rubber grout-hose, directly-connected with the grouting machine and with the 2-in. iron casing pipe. The pressure under which the grout was injected, starting from 10–15 lb. per sq. in., was gradually increased as the hole tightened up until the maximum permissible pressure was reached and no more grout could be injected. The maximum pressure was in every case calculated so as not to exceed the static pressure due to the weight of the ground lying above the fissure and rarely exceeded 95 lb. per sq. in. The grout was usually mixed in a high-pressure grout-mixer and ejector in the proportion of 50 kilograms of cement to 80 litres of water, no sand being used unless the fissure was very large.

An idea as to the size of the fissure and, therefore, as to the possible quantity of grout that would be necessary to inject was usually given by the head of water in the drilled hole above the fissure and by the amount of water lost through it, measured in gallons per minute. The fact that the head of the water was almost invariably found to be below the reservoir water-level proved that no connexion between the reservoir water and the fissures was present. The height of water in the hole above the level of the fissure also gave a means of judging the pressure required to make the grout travel through the crevice, as well as whether the hole was in any way connected with an adjacent hole or holes which had not been finally grouted.

Starting with the lowest initial pressure governed by the total depth of the fissure from the surface of the ground and by the height of the water level in the hole above the fissure, the grouting continued until the hole " tightened up "—*i.e.*, until it was noted that more pressure is required to make the grout travel in a certain time. The latter fact was considered as a sign that the fissure would be soon filled up and, therefore, to eliminate the time necessary for the grout to solidify the last batches of grout were usually prepared of quick-setting cement. Since no more grout could be made to pass into the hole at the maximum pressure for the particular depth permissible, the grouting operation was considered as completed and the hole was usually immediately washed out down to a depth of a few feet above the fissure, after which, the remainder of the grout in the hole was allowed to set solid.

The next operation consisted in cleaning out the solidified grout down to the drilled bottom of the hole with a fish-tail bit or, should the grout have set too hard, to rebore it or redrill it with a diamond bit. On reaching the original bottom of the hole regular drilling proceeded further until a new loss of water or a caving necessitated fresh grouting.

In the second type of operation, when it became necessary to stop a portion of the hole from caving, the following method of grouting was employed : A length of ordinary $\frac{3}{4}$-in. iron pipe was lowered into the hole so that its bottom was reached. The hole was then vigorously washed out by pumping

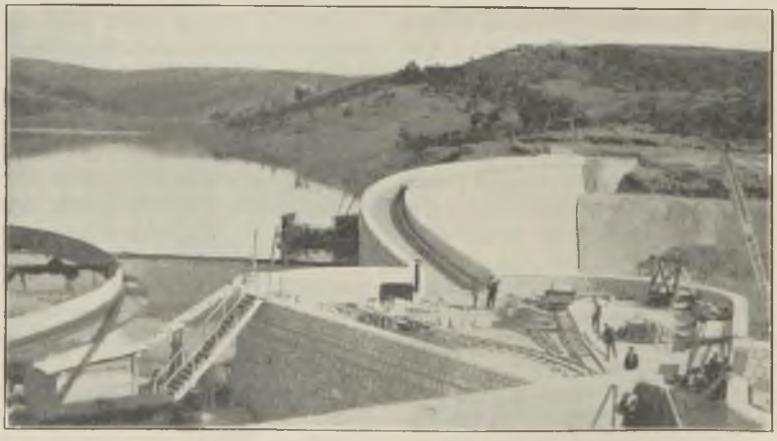


Fig. 3.—South Abutment of the Marathon Dam, Showing a Drill Mounted on a Scow.

FIG. 4.—CLOSE VIEW OF DRILLING SCOW AND OF THE CEMENT AND CEMENT-SCREEN SCOW.

through water under pressure from above until the return of water through the 2-in. casing pipe was clear of cuttings, sand, mud, or clay. A thick mixture of grout (50 kilograms of cement to 60 or 10 litres of water) was then injected through the same pipes, allowing the grout to fill the hole from its bottom, so that the grout, in its rise upwards, could carry with it or could thoroughly mix up with the caved material still present in the hole, as well as fill up any cavity formed by the vigorous washing. This operation being finished, the $\frac{3}{4}$-in pipes were quickly withdrawn and the grout was then washed out to a depth of a few feet above the noted caving portion of the hole, the remainder of the grout being left for several hours in the hole in order to set solid. After the complete setting of the grout has been verified, this portion of the hole was usually rebored or redrilled. In the case of filling a fissure with grout, ordinary grey cements were used, except for the last few batches, for which quick-setting hydraulic cement was employed. In the cases of stopping a cavy portion of the hole only the latter brand was usually employed. However, even the use of quick-setting cement did not prove entirely satisfactory, for, owing to the presence of cold water in the holes, the setting time of the grout was not as fast as it would have been under normal conditions and consequently the delay in waiting for the grout to set was but insignificantly reduced as compared with the time necessary for the complete setting of the ordinary Portland cement, almost invariably six to eight hours being required to elapse before further drilling could be resumed. In addition, the quick-setting cement had a peculiarity in that it would remain in a semi-liquid state for several hours and then suddenly, almost in a few minutes, solidify to an extent which excluded the possibility of cleaning the solidified grout with a fish-tail, redrilling with a diamond bit being invariably necessary. In consequence, every grouting involved a great loss of time, a reduction of progress, expenses in wages of the personnel that had to stand by at the drill, apart from the frequent necessity to redrill more or less large portions of the hole, a fact which, in its turn, involved a further loss of time, wages, etc., together with a considerable loss of diamonds worn in the process of redrilling.

The particular properties of each brand of cement having been carefully studied, a series of experiments and test groutings was carried out with the object of obtaining a composition which would quickly set to a hardness sufficient to hold tight a leak in the fissure or to bind solidly with the caves and which at the same time would remain in this state of hardness for a sufficiently long time before its complete petrification takes place, so as to allow for the grout to be cleaned out by means of a fish-tail instead of it being redrilled with a diamond bit. It was found that

a composition grout consisting of 37·5 kilograms of ordinary grey Portland cement and of 12·5 kilograms of quick-setting (hydraulic-black) cement, mixed in 80 litres of water, gave the desirable results. At the end of from three to four hours from the time the grouting has been finished the grout will be set to a hardness which would be sufficient to stop a leak in the fissure or, in case of caves, to bind up with same so as to prevent them from falling and filling the hole. Remaining in this state of hardness for not less than another three to four hours have expired before the final solidification takes place, ample time was in this way available for the washing out of the grout by means of a fish-tail, without any fear of causing a stopped leak to develop again or, in the case of caves, to destroy the binding crust of grout formed around the walls of the hole.

In this way the use of the composition cement grouting led to a considerable decrease of time necessary to allow for the grout to set, the hole being usually cleaned out of all grout and ready for further drilling inside of four to five hours after the grouting had been finished, and almost entirely eliminated the necessity of re-drilling any portion of the hole, since no sudden solidification of the grout to a hardness that would impose the use of the diamond bit took place before six to eight hours had expired from the time the grout had been injected.

Only in special cases—such, for example, as the persistent caving of a portion of the hole—was the grout allowed to petrify completely, ready for re-drilling with a diamond bit. In those cases, however, the setting time of the grout was considerably speeded up by reducing the proportion of water in the mixture or by slightly increasing the proportion of the quick-setting cement.

Table 3

Operating Cost Per Hole

The operating cost per hole is comprised of the following items :—

	$	$
Diamond-stone setters and superintendent's salary		85·69
Removing and setting rig in new position		22·00
Boring and drilling operation wages		48·30
Diamonds		118·80
Artificial diamonds (Sulamite and Widia cubes)		3·566
Fish tail and cross bits		1·99
Pipe embedded and lost—		
Pipe embedded	2·884	
Pipe lost	0·950	
		3·834
Setting and grouting in of 2-in. casing pipes—		
Wages	2·32	
Materials	0·75	
		3·07
Motive power (air)		25·87
Wash water supply		28·75
Electric lighting		1·80
Repairs and maintenance		9·00
Installation materials		1·35
Total operating cost per hole		$354·02

The actual performance per hole amounting to 229·52 feet, the average operating cost per foot of performance is equal to $1·545.

The average depth of finished hole being equal to 181·41 ft., the average operating cost per foot of finished hole is equal to $1·907.

Table 4

Grouting Costs

	$	$
Wages	8·96	
Wages for the time spent in waiting for the setting of the grout and in washing same out of the hole	27·81	
Cement injected	67·25	
Wash water supply	1·13	
Compressed-air supply	1·52	
		106·67
Deducted cost of grouting in of the 2-in. casing pipe, included in the operating cost		3·07
Total cost of grouting per hole		$103·60
Cost of grouting per foot of performance		0·4513
Cost of grouting per foot of finished hole		0·5711
Combined Costs—		
Operating and grouting cost per hole		457·62
Operating and grouting cost per foot of performance		1·996
Operating and grouting cost per foot of finished hole		2·478

Conclusion.—It should be noted that the execution of all drilling operations was carried out under severe conditions. On the one hand the ground through which the holes were drilled, and specially the stretch lying south of the middle of the dam, was of most uneven and broken up structure. Hard schist, soft clay, or sand seams and quartz-bearing bands, or entire seams were encountered at different depths and elevations. On the other hand a great number of holes had to be started and drilled under great depths of water, presenting in this way many difficulties, not only in driving them, but also in locating and isolating them from the reservoir water, and, generally speaking, constantly causing anxiety.

Regular records of the daily work, progress, and conditions permitted a close watch being kept upon the carbon losses and their immediate causes and, although the greater part of the savings in carbon may be

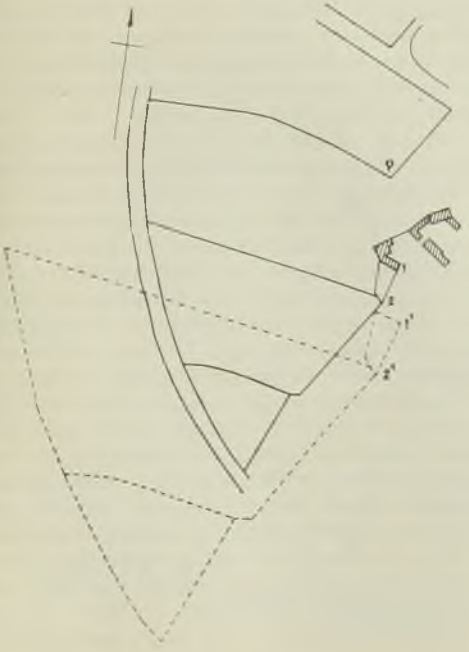
explained by the elimination of redrilling, yet, undoubtedly, a large portion was due to the careful and proper setting of the stones according to the ground conditions as well as to the use of proper speeds and feeds whilst drilling. On frequent occasions, whilst drilling through pure quartz layers, without being able to make any appreciable progress for several hours, no breakages or chippings were noted on account of using special clearances in setting the stones.

The expenditure of diamonds due to wear, tear, and occasional loss was equal to 2·933 carats per 1,000 ft. or 0·9587 carats per 100 metres of actual drilling performance. The expenditure of "Sulamite" and "Widia" cubes was equal to 86·32 cubes per 1,000 ft. or 28·31 cubes per 100 metres of actual drilling performance.

The operating cost of diamond core-drilling was equal to $1·90 per ft. or $6·23 per metre of finished hole.

NOTE ON PRACTICE

Plan Enlarging.—When plotting surface surveys it is often desirable to add certain minor detail that has not been "picked up" on the actual survey. Sometimes this detail is obtained directly from other plans or it may happen that enlargement or reduction is required. There have been several methods of enlarging or reducing suggested, each possessing its relative merits and demerits. The method put forward here is simple, rapid, and at the same time fairly accurate, and is especially useful when only a small area has to be enlarged and the setting up and adjustment of a pantograph or other instrument hardly seems worth while.



The figure shows a small area taken from an ordnance survey sheet (scale 1/2500). During the survey the two roads and the farm were "picked up" and when plotting it was desired to show the position of the fences. The scale of the new plan is 2 chains to 1 inch. Cover the "25-in. sheet" with a piece of tracing paper slightly larger than the area required to be enlarged. Any point P is chosen to serve as a reference point. With a 1/2500 scale measure the distance P 1 (in this case 470 links). Next lay a two-chain scale in the direction of P 1 and mark off a point 1' at a distance of 470 links from P. Now measure the distance P 2 and again with the two-chain scale similarly prick off a corresponding point 2' in the direction of P 2. In a like manner travel along the fences, pricking off the corresponding points to each point which marks a change in direction.

In this case the broken lines show the enlargement of the required fences. The tracing paper can then be removed from the ordnance sheet, fitted on to the new plan, and the position of the fences pricked through. This method can be similarly employed for reduction.

H. G. SMITH.

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

LETTERS TO THE EDITOR

"The Rotary Pan for Diamond Concentration"

SIR,—May I encroach once more on your space to comment on Mr. Sim's letter in your September issue. The expression $\frac{(W - w)\ V^2}{gR}$ is applicable only when the velocity of the body is the same as that of the water, but it can be used in the form

$\frac{WV^2}{gH} - \frac{wv^2}{gR}$ so as to apply to a case where the velocity of the body is less than that of the water and this case is the bone of contention. Now it only needs the second part of the expression to be greater than the first to make the result negative in value. Also, a glance at the expression shows that the opposing forces are equal when $dV^2 = v^2$, where d = S.G. of body. Taking for the body a volume of 1 cu. in. and S.G. = 3 we get W = 0·108 lb. Correspondingly we get w = 0·036 lb. Let V = 5 ft. per sec., R = 4 ft., and let V be variable. Now the expression can be worked out for varying values of V :—

V	$\frac{WV^2}{gR} - \frac{wv^2}{gR} =$	C.F. — ?
4·00	0·0134 — 0·0069 =	0·0065
3·00	0·0075 — 0·0069 =	0·0006
2·87	0·0069 — 0·0069 =	0
2·00	0·0033 — 0·0069 =	— 0·0036

This seems to answer Mr. Sim's question regarding the possible existence of a negative centrifugal force. I prefer to think of it as pressure towards the axis of rotation just as I prefer to think of the upward pressure of water rather than a negative force of gravity. However, this does not affect the issue. Mathematical analysis thus agrees with observed facts and shows that at 4 ft. radius there is a force or pressure towards the centre of the pan of about 0·0069 lb. on a body having a volume of 1 cu. in. As stated in my article published in October, 1932, this figure does not allow for the density of the puddle. It is significant that I should have arrived at almost the same figure from a totally different line of approach, though the connexion is clear. The velocity and the corresponding vortex head vary slightly and had I taken v = 4·9 in the present case the figures would have been identical.

C. W. Walker.

Accra, Gold Coast.
October 8.

[This correspondence must now close.—Ed.]

" Mine Efficiency and the Quota System "

Sir,—I have read with much interest Mr. Bernard Beringer's article in your issue of September. I note, however, with some surprise that this gentleman, whose vigorous contributions to mining literature are always so refreshing, appears to have become an adherent of restriction and the quota system. The solution of the world's problems to-day is certainly racking the brains of all those whom Mr. Beringer specifies, but I venture to predict that the solution will not be found by the adoption of restrictive methods but by increase of consumptive demand. One can only feel that if the same expenditure of brain power, organization, and co-operation that restrictive measures have received had been devoted to increasing consumptive demand our problems would be much nearer solution than they are to-day.

Many will stoutly deny the soundness of this argument, but even the strongest adherent of restrictive policies will, I think, admit that restriction is the antithesis of " the survival of the fittest " or as it is sometimes termed " the law of the jungle." In other words, it is the survival of the unfit and one may pertinently ask why the magic years 1932 and 1933 should be the psychological period in the long history of mankind when the law of the survival of the fittest should be revoked and the law to which we owe our modern civilization should cease to function. If such be the case we certainly commence in those years on the downward path to extinction, for we may be sure that, though man in his wisdom makes this decree, the animal and insect world will not blindly follow and will sooner or later see the extinction of the human race by some virile beast or insect who unreasonably persists in the old law of the survival of the fittest.

We can surely only sincerely trust that many yet remain who believe in this ancient law and by reason of their beliefs so continue the struggle for existence, both personal and commercial, that they continue to progress rather than fall back to the level of the unfit. The subject is one that bristles with complications and one that is far beyond my capabilities to enlarge upon. I have, however, sufficient faith in my fellow men to believe that a solution of present problems will be found, as it has been found before, and can only voice my small protest against the spirit of defeatism so cunningly disguised as common sense that restriction and its inferiority complex must necessarily engender.

R. B. Woakes.

Chota Nagpur, India.
November 4.

NEWS LETTERS

JOHANNESBURG

November 1.

Drought.—Johannesburg, like the rest of South Africa, is in the throes of its severest drought. Natural water supplies that have not failed previously have dried up, with the result that some mines have had an anxious time. It is reported that the Apex Collieries had to suspend normal working on account of there being insufficient water pressure to keep the boilers going. The mines most seriously affected are those drawing their water from the middle Kleinfontein dam, near Benoni, where the level has sunk precariously low. A tunnel is being driven under the dam in order to tap every drop of water in it, work proceeding day and night on double shift. The Rand Water Board has been able to supply a limited amount of water as an emergency measure, but the position is still serious. Most of the mines are now investigating their own water supply from surface and underground sources and the Rand Water Board is expediting the laying of a new pipe-line from Vereeniging, 45 miles distant. The position should be well in hand before the start of the next dry season.

Dust and Sericite.—The drought has been attended by duststorms of unusual severity and for many days and nights the air has been almost saturated with dust. Bearing in mind the fact that all material for roads along the reef is derived from the waste rock dumps of the mines, one wonders to what extent the people of the Rand are affected by the inhalation of sericite fibres. Dr. William R. Jones's new theory as to the cause of "silicosis" has naturally created great interest here and it is known that mines in various districts are investigating their own problems in this respect. It is realized that if Dr. Jones's conclusions are correct they will have a far-reaching effect upon the liability of mines for compensation for miners' phthisis. Some mines now paying into the Phthisis Fund may be found not liable and the opposite may apply in other cases. Experiments are now being carried out with the greatest possible speed at the South African Institute for Medical Research to find a link between the facts ascertained by Dr. Jones and the methods until now believed to be reliable. Evidence is steadily accumulating that the views put forward at the recent full-dress conference of Johannesburg technical bodies concerned are correct and that the principles of phthisis prevention hitherto accepted without question will have to go by the board. Most important of these is the present system of air-sampling.

Great Western Gold Mine.—Mr. F. Kingsley, whose work on the Vaal River was mentioned last month, has been appointed manager of the newly-registered Great Western Gold Mine, which company has acquired the assets of the mine that Mr. Kingsley has managed so successfully with the limited amount of capital at his disposal. The mine is 17 miles from Vredefort and 25 from Potchefstroom, situate on the farms "Elandslaagte" No. 28 and "Misgun" No. 708, in extent 574 morgen. Milling has been carried on from June, 1932, the total tonnage milled being 6,496 and the gold recovery 1,043 oz. The net recovery is about 3·3 dwt. per ton. The grade has been adversely affected by restricted ore reserves, no sorting, and absorption of gold in new plant. In his report on the mine Mr. George Reid states:

> There are two auriferous conglomerate reefs, the Western or Kimberley Reef and the Bird Reef; the latter has not been opened up. The Kimberley Reef strikes north–south for a distance of 3¾ miles. It has a shale hanging- and quartzite foot-wall. The average dip is 65°. The average value is 7 dwt. to 8 dwt. over an average stoping width of 35 in. There is a banded pyritic quartzite in the foot-wall, oxidized at surface, and it can be followed along the strike for 600 yd. It varies in width from 12 in. to 8 ft. Apparently there is no record at the office of the Government Mining Engineer of a banded pyritic quartzite having been associated with the Kimberley Reef horizon and therefore it can only be regarded as a new discovery which will enhance the value of the property.

The capital of the new company is £150,000 in 5s. shares.

Mineral Survey of the Union.—Mr. Patrick Duncan, Minister of Mines, in a recent speech, said that he realized that the time had come when the Government should take a more active and practical interest in the development of the country's resources. He hoped that it would be possible to divert some revenue to the investigation of the Union's mineral resources and possibly next year to institute an adequate mineral survey of the Transvaal. The country's geological survey was far behind that which it ought to be and he hoped to make it more of a reality than it had been in the past Following this speech came the news that

Mr. P. O. Lange, Deputy Inspector of Mines at Johannesburg, has been transferred to Bloemfontein to assume duty as Deputy Inspector of Mines in the Free State and Cape Province. This addition to the personnel of the Free State Department of Mines is understood to be the first step towards a thorough survey of the mineral wealth of the Union.

Rand Leases (Vogelstruisfontein).—The opening up of old and new properties all over the country has caused a remarkable demand for second-hand machinery and mining plant. Merchants of this class of machinery now find themselves practically denuded of stocks. This is the position confronting the Rand Leases company and orders for winding plants and other machinery urgently required are being speeded up, so as to occasion as little delay as possible. The company took over as one consolidated property several old mines in the Florida-Hamberg district, notably the Bantjes Consolidated, the Vogel Deep, and a large additional area from the Government. The mines had been worked under the comparatively crude conditions of extraction formerly prevalent, then closed down. Thereupon the claims reverted with certain exceptions to the Government, but, as the mines and properties were all contiguous, the Government sought a favourable opportunity, when sufficient claims had reverted, to consolidate them into a good paying lease. Thus originated the Rand Leases (Vogelstruisfontein) flotation. Up to the time of closure the chief properties taken over had mined just short of 4,000,000 tons on a 92% basis of recovery yielding 5·94 dwt., which under present conditions would obviously yield over 6 dwt. Recent surveys of the properties have disclosed an estimated 40,000,000 tons of payable ore awaiting development on the Main Reef Series alone, while there are, of course, the Bird and Kimberley series, a conservative estimate of additional tonnage from these reefs being 10,000,000. When production begins it will be at the rate of 50,000 tons a month. Three years later, on a rising output, it will reach the 100,000 tons mark.

Gold Nuggets from Pietersburg.—A nugget of solid gold weighing 13½ oz. and worth £80 was brought into Pietersburg recently by Mr. Oosthuizen. It was found on the farm Eersteling, about 18 miles from Pietersburg, where gold was first discovered in South Africa and worked as early as 1871. This is the largest of many nuggets found by Mr. Oosthuizen recently.

BRISBANE

October 26.

Mount Isa.—Although the Mount Isa mine has very large reserves of zinc the company has not as yet, for economic reasons, recovered and treated them. The chairman has lately affirmed that, while it is the intention of the company to extend its operations to the fullest limit, at the present price of the metal zinc production would not be profitable. At the same time there is the certainty in his mind that metal prices must improve in the near future and this conviction gives the hope that it may be possible soon to embark on a programme of zinc production. The opening up and the making available of zinc ores in the mine is reckoned to cost about £165,000 and to give employment to some 100 extra men. The output of zinc concentrates when production has been begun would amount to approximately 80,000 tons yearly.

Lead Poisoning.—Following the recent investigations by the State Insurance Commissioner (Mr. J. A. Watson) and the Government Pathologist (Dr. j. v. Duhig) into the incidence of lead poisoning at Mount Isa new regulations, under the Mines Regulations Acts, providing for safety measures in regard to lead poisoning, or plumbism, at that mine have been put in force. Under these regulations an obligation is thrown on the Mount Isa Company to make adequate provision to prevent as far as practicable the emission of flue dust from the smelter flues and stacks and to prevent this inspectors of mines have been given extensive powers.

Mount Coolon.—The drilling campaign that was decided on when shaft-sinking was temporarily suspended at the Queensland Mount Coolon mine has been commenced on No. 4 level. In the meantime stoping has been started in various parts of the mine. Driving on the No. 2 level east and No. 9 winze has been continued, together with cross-cutting in both walls and drives on the No. 4 levels.

Mount Morgan.—The Mount Morgan Company is reported to be making excellent progress in the building and modification of the plant at the mine. For the underground crusher the excavations and all the concrete

work has been finished. The No. 14 shaft has been completed and is in use handling overburden. The excavation of the chamber for No. 3 air-compressor is also finished and the compressor itself is being reconditioned. The new Disco filter is already operating, while there will shortly be finished a new drier which is being constructed for drying concentrates. The number of men now employed at the mine is 353. The ore mined last month totalled 12,827 tons and the quantity concentrated was 13,330 tons. Taking gold at £7 an ounce and copper at £37 a ton the total value of the month's output is put at £22,514. The value of the August production, on the same basis, was £20,515 and the average of the ore treated in the latter period (11,220 tons) was 6·57 dwt. of gold per ton and 0·32% copper.

Newnes Shale-Oil.—According to a report from the Newnes Investigation Committee it is estimated that with an adequate plant New South Wales could produce 20,000,000 gallons of oil from shale each year. This committee, which was appointed by the Federal Government, calculates that there is more than 40,000,000 tons of good shale at Baerami and Newnes and expects that with a modern cracking plant something like 5,000,000 gallons of oil could be produced there annually at a cost of 8d. a gallon. Imperial Chemical Industries, Ltd., has undertaken to furnish plans and an estimate of the cost of a plant for the hydrogenation treatment of 150 tons of shale-oil per day. All the work at Newnes for opening up the tunnels, as well as for sampling and measuring the oil-shale seam, has been completed.

Broken Hill South.—For the year ended June 30 last the accounts of Broken Hill South, Ltd., disclose a profit of £240,673, against £117,226 for 1931-32. The mining section of the company's business gave a net profit of £154,767, while the investment section contributed £85,906. The net return from mining, arrived at after providing £33,000 for depreciation of mine plant and £35,400 for taxation and New South Wales Government royalty, was £144,396 higher than for 1931–32.

Deep-Lead Mining.—Mr. F. W. Baker is in Melbourne investigating the possibilities of deep-lead mining in Victoria. He has obtained options over several mining leases and upon these some preliminary boring has already been done. Mr. Baker has also taken an option over the old Talbot mine, where plant is being installed. He is satisfied with the prospects and states all the capital necessary to develop the mine will be forthcoming as circumstances justify the expenditure. Work done already indicates that the mine would be payable with the par price of gold.

Western Australia.—The still-improving returns of gold production in the various Australian States for nine months of this year show that Western Australia has still further strengthened its position at the head of the list. Excitement was caused in Kalgoorlie, Western Australia, the other day when two prospectors who have been working at Mulline, north of Kalgoorlie, took into one of the banks four bars of gold weighing 1,660 oz. The gold, which is valued at £12,000, was the proceeds of a crushing of 52 tons and was the result of nine weeks' work.

Northern Territory Gold.—A good deal of interest has been taken during the past month in another discovery of ore-bodies carrying gold values in the Northern Territory of Australia. This time the locality of the find is The Pinnacles, at Tennant's Creek, 320 miles from Alice Springs, on the main road to Darwin. As usual with these finds there has been a rush for mining leases and, with little or no testing of the ground, options have been sold for large sums of money. The chief warden at Darwin (Mr. Norman Bell) has twice been to the locality. He says that it will be many months before it is learned whether the field will prove a paying proposition. About 40 experienced miners were on the field at the time of Mr. Bell's visit.

VANCOUVER

November 10.

Cariboo.—At a distance of about 2,200 ft. from the portal the main tunnel of Cariboo Gold Quartz Mining Company has encountered a vein that is believed to represent the first of the Sanders series, which constituted the original objective of the development work. The tunnel is being advanced at the rate of about 15 ft. per day, with two drills in operation at the face. A mucking machine and electric haulage are employed. Exploration is still active in near-by sections of the area, but there has been a general lack of encouragement in connexion with many speculative ventures that were initiated at the commencement of the year and Premier

Gold Mines, Ltd., has relinquished all the options that were held by it and has withdrawn from the field. Cariboo Amalgamated Gold Mines, Ltd., which was incorporated recently, is reported to be about to commence the driving of a cross-cut tunnel to explore particularly favourable showings on the Liberty and Free Gold claims near Barkerville. Cariboo Central Gold Mines Company, representing Washington interests, has commenced the driving of a 3,000-ft. tunnel to explore a number of veins that were exposed in the Lowhee Creek placer workings. This working would attain a depth of about 1,150 ft. below surface, or nearly twice that of any exploration yet carried out in the area.

Bridge River.—The decision of Pioneer Gold Mines to carry down the No. 2 shaft from the 10th to the 15th level is further proof of the importance of the developments in the eastern section of the mine workings. This shaft was sunk for the purpose of developing the mine below the 500-ft. level after the continuity of the ore-body had been successfully proved within the limits that were possible from the original workings. The additional provisions for hoisting will be of great assistance to the further development of the eastern section and are clearly necessary if and when the sinking of the main shaft is continued. It is understood that the further development of the B.R.X. property is to be undertaken by diamond drilling and a contract has been let for an extensive programme of this work. One of the chief objects will be the exploration of the foot-wall vein, which is now considered to offer more promise than the main California vein, upon which most of the work has been done. It is reported that the Pioneer Extension, Dan Tucker, and Plutus properties, lying above the Pioneer ground to the south-east, are to be amalgamated under one control. The exploration work on these properties during the past season has been under the direction of Colonel H. H. Yuill, who is also acting as consulting engineer to Grull Wicksne Gold Mines. At this property the original plan of driving a cross-cut tunnel has been abandoned in favour of sinking a shaft to a depth of 100 ft., from the bottom of which diamond drilling exploration is to be carried out. The objective of this work is to prospect for the favourable diorite formation, in which it is anticipated that veins of economic importance may be found. Meanwhile a drive is being run on the best showing that has been uncovered by surface workings. Efficient surface work has been done by B.C. Cariboo Goldfields, Ltd., on the Comstock group, where, by means of a 25-ton caterpillar shovel, a trench has been dug averaging 7 ft. to bedrock for a distance of over 3,000 ft. This work was completed in 18 days at a cost of 42 cents per lineal foot. It is reported that some promising veins have been exposed which are to be further explored by diamond drilling.

Nelson.—After a long period of idleness the California mine, adjoining the Venus-Juno-Athabasca group on Morning Mountain, has been reopened and an initial shipment of 33 tons of ore has been made to the Trail smelter. The vein is described as a quartz-filled fissure in a band of schist near a granite contact. Gold values are associated with zinc blende, pyrite, and galena. The property consists of five claims and in former days the ore was treated in the old Athabasca mill. The Tamarac mine, in the Ymir section, has been acquired by a New York company. This is one of the oldest properties in the district, having been located in 1896. The Euphrates property, situated at Hall Siding, a few miles south of Nelson, has been acquired by Spokane Idaho Copper Company. Recent prospecting work is said to have disclosed a wide ore-shoot on the Lost Cabin vein on this property. It is said that there are good chances of opening up a large gold mine by treating it as a low-grade proposition instead of selectively mining small rich shoots, as was done in past operations. Active operations at this property are said to be in progress. Reports of developments at the Reno mine, at Sheep Creek, continue to be favourable, particularly in regard to the lower level.

Portland Canal.—A statement has been issued by Dale L. Pitt, general manager of Premier Gold Mines, Ltd., to the effect that there is no foundation for rumours which have been in circulation in regard to the early closing down of the Premier Mine. Mr. Pitt states that the plant continues to operate at full capacity and will continue to do so until all the ore reserves are exhausted, which from the present viewpoint will not occur inside a year. Dunwell Mines, Ltd., has decided to resume operations as a result of an improved outlook in regard to ore reserves, which is stated to have been brought about by the work done by leasers in different sections of the Dunwell property during the

past year and in view of the better silver situation. The company's operations terminated abruptly in 1927 after milling about 27,000 tons—all the available ore reserves. It is proposed to re-equip the mill on the basis of a capacity of 40 tons per day and to resume operations in the early part of next year. Work at the Big Missouri mine is to be resumed under the auspices of the Consolidated Mining and Smelting Company. It is understood that this step has been decided upon following the acquisition of a large interest in Big Missouri Corporation, Ltd., by the Quebec Gold Mining Corporation. The board of the operating company includes four directors of Quebec Mining Corporation and W. M. Archibald, manager of mines of Consolidated Mining and Smelting Company, is also vice-president. The Big Missouri mine has up to the present time defied all efforts to obtain a satisfactory estimate of its commercial possibilities. It has been recognized for several years that the possibilities of this property, lying to the north of the Premier mine, are unusually large and extensive developments have been carried out by tunnelling and diamond drilling work with a view to ascertaining whether the erratic distribution of values in the wide zones of mineralization might be relied upon as a basis for profitable operation on a large scale. The exhaustive investigation was further assisted by the construction of a 100-ton mill as a practical means of obtaining reliable run-of-mine sampling. This plant was operated for several months in 1931 by Consolidated Mining and Smelting Company, but the property still remains an enigma.

Hope.—A considerable amount of interest in shown in the activities that are in progress at the nickel properties near Hope. The outline of the arrangements that have been made between B.C. Nickel Mines and the interests represented by Ben Smith, of New York, Colonel Victor Spencer, of Vancouver, and David Sloan, of the Pioneer mine, have been disclosed and provide for the payment to the company of $175,000 for settlement of its liabilities, the turning over of 45 additional claims, and the provision of funds for the prosecution of the ambitious scheme of development that is in hand. This work includes the driving of a double-track tunnel for a distance of over 4,000 ft. to provide for the development of the anticipated reserves of ore at considerable depth. It is stated that an average chromium content of from 1 to 2% has been found in the nickel-bearing pyrrhotite and, if the results of the development are satisfactory, the assurance is given that immediate steps will be taken to install the necessary smelting, refining, and electrical works for the manufacture of chrome-nickel steel on a large scale. It is proposed to increase the capitalization of the company to $6,000,000.

Boundary.—The development of the Jewel mine, near Greenwood, has been productive of highly encouraging results, according to reports received from Major Angus Davis, who is in charge of the work for Dentonia Mines, Ltd. Hecla Mining Company has relinquished its option on the Homestake property in the Franklin camp after failing to obtain results of sufficient encouragement from the exploratory work that has been in progress during the past year. The company is now confining its activities in the camp to the construction of a cyanide plant for the purpose of treating the accumulation of tailing from the Union mill next year. A first shipment of silver-lead ore, amounting to 41 tons, has been made from the Beaver Silver mine at Beaverdell. Owing to the demands of development, this ore, upon which a net profit of £2,147 is stated to have been realized, did not represent the best grade of ore in the shoot that is being followed. Another shipment of a considerably higher grade is expected shortly and it is understood that negotiations are on foot for the introduction of Montreal capital for the purpose of expanding the scope of operations. All the high-grade silver-lead mines in this camp are doing well under present conditions of the market price of silver.

Vancouver.—The programme of the annual Western meeting of the Canadian Institute of Mining and Metallurgy, in Vancouver, from November 15 to November 17, embraces several features of general interest. Among these are the addresses by Dr. Charles Camsell, Deputy Minister of Mines for the Dominion, a popular lecture on "Mining of the Romans" by Dr. T. A. Rickard, "Mining Engineering Ethics" by Dr. H. A. Warren, and "Protection of Mine Investors" by J. D. Galloway. Reviews of mining in Manitoba, Alberta, and British Columbia are dealt with by Geo. E. Cole, J. A. Miller, and J. D. Galloway respectively and the gold-mining industry of the western province is covered by a whole session devoted to addresses

by the resident mining engineers. "Large Scale Blasting at Anyox" by W. R. Lindsay and R. L. Healy, "Development of the Bralorne Mine" by R. W. Bosustow, "Some Notes on the Bridge River Gold Belt" by Dr. V. Dolmage, "Flotation Practice at the Britannia" by H. A. Pearce, "Theory of Magma Waves" by Douglas Lay, "Power in Mining" by W. R. Bonnycastle, and "What a Minister of Mines Should Know" by H. G. Nichols are included in a full programme.

TORONTO

November 18.

Gold Production.—Ontario's gold production for the month of October had a total value of $3,448,362, an increase of $81,464 over September's total of $3,366,898 but a decline of $460,038 from the $3,908,400 recorded for October, 1932. Ore milled for October totalled 484,706 tons, compared with 454,875 in September. Gold production for the whole of Canada totalled 235,596 oz. for September, which was 20,965 less than the 256,561 oz. reported for August. September's output had a value of $4,870,201. Canada's production for the nine months ending with September totalled 2,205,736 oz., a decline of 74,373 from the total of 2,280,109 oz. for the first nine months of 1932.

Porcupine.—October's production in this area amounted to $1,665,477, compared with $1,733,824 for September. Output of Dome Mines totalled $350,906, as against $356,933 for September, and $308,513 for October, 1932. Milling operations and recovery were at about the same rate as in the previous month. Bullion produced for the ten months ending with October had a value of $3,813,000, exclusive of premium, an increase over the $3,486,945 recorded for the same period of 1932. McIntyre Porcupine Mines' net income for the six months ending September 30, the first half of its fiscal year, was $1,755,289, an increase of $627,569 over the net of $1,127,720 for the corresponding period of last year. Gross income for the period was $3,911,053, compared with $2,899,153, an increase of $1,011,200. Costs, including development, totalled $1,618,558, as against $1,495,563. Premium of $107,672 earned by Vipond Consolidated Mines brought its total bullion proceeds up to $586,402 for its fiscal year ending July 31, 1933. Bullion produced by the mine and mill had a value of $478,730, exclusive of gold premium, representing a recovery of $4·31 a ton from 110,962 tons milled. This compares with production of $478,021 for the previous year, with recovery of $4·69 a ton from 102,000 tons milled. Cost of production, before depreciation and other charges, amounted to $532,273, or $4·80 per ton milled, compared with $5·82 per ton for the preceding year. Anglo-Huronian, Ltd., a merger of Huronian Mining, Vipond, and Keeley, has taken control of Night Hawk Peninsular Mines, one of the older properties in the Porcupine area. Underground workings have been carried to a depth of 625 ft., with six levels partly opened up, and the new company plans a large programme of development. The Churchill Mining and Milling Company has ordered a 10-ton mill for its property in the Shining Tree district. The shaft at Coniaurum Mines has reached a depth of 3,000 ft. and plans call for a cross-cut to pick up the continuation of the new vein system on the 1,500-ft. horizon.

Kirkland Lake.—This area led all other Ontario mining areas in production for October, its total output being $1,684,889, compared with $1,558,664 for September. Lake Shore Mines had a bullion recovery of $2,601,362 from 208,950 tons of ore for the three months ending with September, an average recovery of $12·48 per ton exclusive of premium. For the fiscal year ending June 30 the company reported a profit of $7,215,192, compared with $7,797,011 for the previous year. Income from production totalled $13,277,685, including premium, the total revenue standing at $13,414,086, compared with $13,893,992 a year ago. During the year bullion recovery amounted to $11,406,307 from 797,673 tons of ore, an average of $14·30 per ton, as against $12,356,759 from 834,434 tons for the previous year, an average of $14·80 per ton. Wright-Hargreaves Mines, another important producer, had a net profit of $1,865,756 for the eight months ending August 31. Income from bullion amounted to $3,201,444. After deducting operating costs of $1,382,431, operating profit stood at $1,819,013. A total of 193,441 tons of ore was milled, having an average recovery of $13·56 per ton. During the period the work of carrying shafts 3 and 4 to 4,000 ft. and establishing new levels was practically completed, while 239,563 tons of new ore was developed. The north vein was intersected on five out of six of the new levels, the lowest of which is 3,900 ft. The mill will

be increased to bring its handling capacity of ore up to 1,000 tons a day. Macassa Mines is now on a regular basis of production and the mill will be gradually stepped up to its capacity of 200 tons. Teck-Hughes Gold Mines had a bullion production of $6,139,175 for the year ended August 31, which with interest of $107,411 brought its gross income to $6,246,686. After deduction of all expenses and taxes a net surplus of $3,229,009 remained. Ore treated during the year totalled 474,500 tons. At the Boston Creek property of Barry-Hollinger Gold Mines the winze has reached its present objective at 2,250 ft., with a sump of 25 ft. below this level. It is planned to have the mill resume production early in December.

Sudbury.—Falconbridge Nickel Mines, Ltd., had a net profit of $256,534 for the three-month period ending with September, as compared with $271,355 for the previous three months. During the period under review the company treated 68,249 tons of ore and produced 2,708,244 lb. of nickel matte and 1,252,218 lb. of copper matte. In the preceding three-month period 58,720 tons of ore was treated, 2,307,501 lb. of nickel matte and 1,040,335 lb. of copper matte being produced. Refined nickel production at 2,043,507 lb. showed a considerable increase over the 1,530,874 lb. reported for the three months ending June, while copper at 956,408 lb. compared with 610,385 lb. Gross operating profit was $352,870, as against $346,757, the total income being $380,440, compared with $387,117. Completion of the diamond-drilling programme at the Lee Gold Mines property in the Greenlaw section of the Swayze gold area revealed good mineralization to approximately 300 ft. The company plans to purchase a mining plant in the immediate future.

North-Western Ontario.—Howey Gold Mines produced bullion to the value of $280,600, including premium, from 76,305 tons of ore for the three months ending with September. This represented an increase of $1,600 over production for the previous quarter. Gross operating profit was $94,500, compared with $92,000. Costs are now running under $2 per ton and it is expected to reduce them eventually to about $1·75 per ton. Installation of additional milling equipment has increased ore treatment capacity to the rate of about 1,250 tons daily. The mill at the property of Parkhill Gold Mines, in the Michipicoten area, is treating between 70 and 75 tons of ore per day. Good progress is being made by St. Anthony Gold Mines in its preparations to place the property in production by the end of the year. Construction of the hydro-electric transmission line is on schedule, while the mill is nearing completion. Diamond drilling on the Springer group of Central Patricia Gold Mines has yielded encouraging results. At the main property underground operations will be commenced on December 1 with a view to preparing the mine for production next spring. An extensive development programme is being undertaken by Horseshoe Mines, Ltd., at the old Regina Mines property in the Lake of the Woods district. Wendigo Gold Mines, Ltd., in the same district, is preparing to install a mining plant, an important ore-body having been located on the property.

Quebec.—Noranda Mines had a total production of 47,371,031 lb. of anodes, with a recovery of $8,812,372, for the nine months ending with September. This compares with 45,301,442 lb. of anodes and recovery of $9,193,608 for the same period of last year. Net profit was estimated at $3,033,435, compared with $2,819,853 for the first nine months of 1932. The lower recovery is attributed largely to the low price for copper which prevailed during the period. A new monthly production record was established by Siscoe Gold Mines in October, when recovery amounted to $104,211, exclusive of premium, as compared with $101,719 in September, and $80,419 in October, 1932. Addition of premium is expected to bring the returns for production up to $156,500. Ore treated amounted to 9,533 tons, with an average grade of $11·21 per ton. Good progress is being made in development work on various levels of the property and ore reserves are being extended. The new mill on the property of Greene Stabell Mines is now ready to start operations. Shaft-sinking has been started by Adanac Gold Mines, in the Rouyn district of Quebec. Exploration work on the Granada Gold Mines' new north showing has revealed heavy mineralization to a depth of several hundred feet and drill core assays run from $4 to $17 per ton gold. At the main property the mill is handling about 100 tons per day. Rapid progress is being made with development work at Lamaque Gold Mines, in Bourlamaque Township, controlled by Teck-Hughes Gold Mines. The No. 5 shaft has reached a depth of 50 ft. and construction of a mill is planned.

Manitoba.—Diamond drilling on the Akers group of the God's Lake Gold Mines' property, in Northern Manitoba, has revealed two ore-shoots with a combined length of

1,000 ft., yielding average assays of $15·40 per ton in gold. The width averages more than 6 ft. The vein has been blocked out to a maximum depth of 560 ft., where ore was encountered and ore reserves of more than $5,000,000 to a depth of 500 ft. are indicated. An additional 10,000 ft. of diamond drilling is being undertaken immediately. It has also been decided to install two 80-h.p. and one 60-h.p. boilers, a mining plant, compressor, and hoist. Smelter Gold Mines will sink its first shaft on the high-grade section of No. 1 vein, which is 7 ft. wide on surface and wider at depth. Diamond drilling will be started on the Akers vein, which parallels No. 1 on the south. The new mill at the Oro Grande Mines property, in the Central Manitoba gold area, is now treating between 35 and 40 tons of average mine grade ore per day. A large tonnage of ore will be placed ahead before the mill is speeded up. Mine development has opened up a number of sections of high-grade ore. Preparations are being made for an extensive development campaign on the Gunnar Gold Mines property, in the same area. Five veins located on the surface carry high-grade ore, with considerable free gold. A shaft will be sunk to a depth of 500 ft. and cross-cuts will be driven to pick up the veins, after which driving will be carried on.

PERSONAL

E. H. Ackermann has left Bechuanaland for Leipzig.

R. Allen is home from the Gold Coast.

J. P. Bolt has left for Kenya.

A. L. Brichant has left Belgium for Mexico.

C. B. Brodigan has returned from West Africa.

F. C. Cann has left for Panama.

Alan Cawley has left for the Gold Coast.

J. T. Chapfel has returned from Malaya.

J. C. Davey has left for Venezuela.

A. F. Dick-Cleland is home from Nigeria.

Oscar Falkman, managing director of the Boliden Mining Company, has been awarded the Nobel memorial gold medal of the Royal Swedish Institute for Engineering Research and Axel Lindbled, technical director of the company, has received the gold medal of the institute.

Donald Gill has left for Western Australia.

J. A. L. Henderson is home from Canada.

W. R. Jones has returned from a visit to South Africa and East Africa.

H. W. Laws is home from British Colombia.

C. Leach has left for Nigeria.

G. M. S. Leader has left Yugoslavia for Kenya.

R. J. Lemmon has returned from a tour of a number of South American mines.

V. F. Stanley Low has left for Brazil.

A. M. Mackilligin has left on his return to Brazil.

D. K. T. MacLachlan is home from Nigeria.

J. Malcolm Maclaren has left for Mexico.

Alexander Mather is returning from Nigeria.

John Parkinson has left for Tanganyika.

A. V. Paull is returning to Venezuela.

T. L. Robb is home from Southern Rhodesia.

A. W. Ross has left for Sierra Leone.

Bernard H. Sanders is returning from Brazil.

S. G. O. Trelease has left for the Gold Coast.

W. G. Tyson is now in Colombia.

L. Vaughan is returning from Malaya.

J. C. Vivian has left for Spain.

H. H. Watson has left for British Guiana.

J. J. White is returning from the Gold Coast.

J. Norman Wynne has left for Kenya.

Pope Yeatman is to be awarded the Saunders medal of the American Institute for 1934.

Charles W. Trenholme died in Montreal on November 15, aged 72. He graduated from McGill in 1885 and was the first student to win the British Association gold medal there.

Charles Butters passed away last month, at the age of 79. Mr. Butters was president of the Exploration Company of California and a Member of the American Institute of Mining and Metallurgical Engineers. He will, however, be best remembered as the engineer responsible for the introduction of the cyanide process into South African mining some 40 years ago. From one who was closely associated with Charles Butters for many years has come the following appreciation :—" Charles Butters's enthusiasm, tireless energy, and personal magnetism—his human understanding and consideration for others—were of such an order that those associated with him, from even the lowest grade, were inspired and spurred to greater efforts. His mental agility and rapidity of thought enabled him to form sound conclusions, make up his mind, and lay his plans while a slower mentality would be vacillating and 'sitting on the fence.' . . . Probably his first big work was the formation of the Rand Central Ore Reduction Co., close to Johannesburg, an organization that covered pretty completely everything on a gold mine at that date. . . . In Sonora Charles Butters was responsible for the first modern mechanized cyanide plant, handling sands and slimes, on the American Continent. In Salvador and other parts of the New World there have been and are other signal reminders of his ability and energy. It is not too much to say that the mining industry as a whole owes to Charles Butters and his supporters a debt which may have been paid in appreciation, but not in concrete values."

TRADE PARAGRAPHS

General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2, in their *Journal* for November, publish an article describing the " Chance " sand-flotation system of cleaning coal.

George Cohen, Sons, and Co., Ltd., of 600, Commercial Road, London, E. 14, have published a list giving in tabulated form the particulars of their stock of a.c. and d.c. reconditioned electric motors.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, in their *Edgar Allen News* for November give particulars of solid manganese steel dredge tumblers and instance the use of them for tin dredges.

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, issue a booklet on jaw-crushers. This deals with crushers of the Blake and Dodge types and also contains particulars of ore feeders, automatic samplers, and diaphragm pumps.

Austin Hoy and Co., Ltd., of Bush House, London, W.C. 2, have been appointed agents and distributors for the Great Western Electro-Chemical Co., of San Francisco, for the sale in Europe of the Xanthates marketed under the name of "Bear Brand."

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, in their *Gazette* for November, 1933, publish an illustrated article describing in detail the three 20,000 k.v.a. synchronous condensers which they have installed for the Victoria Falls and Transvaal Power Co., supplying power to the gold mines of the Rand.

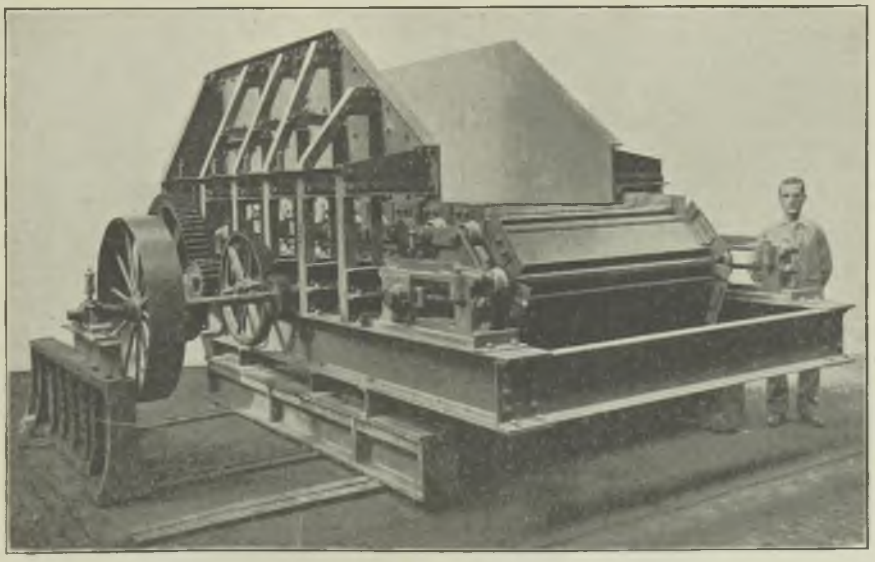
Mond Nickel Co., Ltd., of Thames House, Millbank, London, S.W. 1, issue their latest technical publication on the attributes of nickel alloy steels. Photographs are shown depicting various components of dredges supplied to the Bulolo Gold Dredging Co. and transported to New Guinea by air, in which this steel was used in order to obtain strength with lightness.

Sir Isaac Pitman and Sons, Ltd., of Parker Street, Kingsway, London, W.C. 2, publish parts 29 and 30 of their *Engineering Educator*. Part 29 contains the conclusion of the section on prime movers, chapters on refrigeration machinery, and the commencement of the section devoted to fans, blowers, and air-compressors. This section is completed in part 30 and is followed by six chapters on pioneers of engineering.

Swedish Diamond Rock-Drilling Co., of Stockholm, Sweden, have issued Bulletins Nos. 101 to 109 dealing with diamond core-drilling on the Craelius system. These publications cover core drills and their component parts, piston pumps for hand and power drive and various capacities and their component parts, drill rods and couplings and hoisting tools for the same core tube sets—including extensions, couplings, and drilling bits—and casing tube sets with various accessories. Another publication which they have issued refers to the services which they offer for cement grouting for a variety of constructional engineering and mining purposes. Examples are given of the successful grouting of gravel and concrete and of the application in dam construction and the sealing off of incoming water. Details are cited of many contracts carried out in different parts of Europe.

Davidson and Co., Ltd., of Sirocco Engineering Works, Belfast, have prepared a leaflet giving particulars of their Aeroto fans for auxiliary mine ventilation. These are a special type of screw fan for operating in conjunction with a line of ductwork for booster ventilation below ground and for the supply of fresh air to dead-ends and similar positions. The fan rotor, which has been designed on aerodynamic principles, is cast in one piece from a special aluminium alloy, bored and keyed to fit the motor spindle. Suitable guide vanes attached to the fan casing adjacent to the fan rotor rectify the air current and maintain a streamline air flow. The driving motor has a continuous rating of 3·5 b.h.p. at 2,880 r.p.m. on a low-tension supply. Examples of performance are quoted which show the volume of air delivered in cubic feet per minute for given lengths of 22-in. diameter steel duct and the corresponding horse-power absorbed. Thus for 100 ft. the volume is 7,750 and the h.p. 3, for 600 ft. 6,110 and 3·45, and for 1,500 ft. 4,120 and 3.

Hadfields, Ltd., of Sheffield, issue information with reference to their pan feeder, which has been designed for controlling and regulating the supply of material to primary crushers. Structurally it consists of rolled steel plates, channels, and angles supported on two heavy girders, which also carry the driving gears in addition to the head and tail shafts. The pans, or trays, each consist of a pressed mild



HADFIELD PAN FEEDER.

steel tray of trough section and a rolled steel channel, between which is interposed a solid oak filling, the whole forming a resilient beam well able to absorb the shocks caused by falling pieces of material. The pans are attached at each end to a chain formed of steel links provided with cast steel rollers, which run on rail tracks supported on substantial cross-members of channel section stretching across the two main girders. Intermediate rails are also provided to prevent flexure of the pans under heavy weights and, to counteract any wear that might take place, the pans are fitted with wearing strips on the underside. The side skirts of the feeder are very strongly constructed, being well supported at every point to resist the pressure of heaped up material, and are lined with renewable mild steel wearing plates. The chains carrying the pans are actuated by sprocket wheels mounted on steel shafts at each end of the machine, motion being imparted to the shaft at the head end by means of reduction gearing, belt driven. The gearing is made in Hadfield's best toughened cast steel and both wheels and pinions have machine-cut teeth. At the tail end adjusting screws are provided to enable the chain to be maintained at a suitable tension. The rate of travel of the pans is generally from 10 to 20 ft. per min., but the best speed in practice will depend upon circumstances and for this reason a variable-speed motor is recommended for driving it. The pan feeder illustrated measures 54 in. wide and is 10 ft. between the sprocket wheel centres. Considering the heavy work that feeders of this class are called upon to perform in action they run very smoothly, require very little attention, and may almost be put in the fool-proof category. Where they have been in service over considerable periods experience has proved that they rarely, if ever, fail through mechanical defects and the call for renewals is negligible.

PUBLIC WORKS, ROADS, AND TRANSPORT EXHIBITION

The Public Works, Roads, and Transport Exhibition was held, as in former years, at the Agricultural Hall, London, N., from November 13 to November 18, and among a number of exhibits of interest to mining men those of the firms mentioned below were outstanding.

H. R. Marsden, Ltd., of Soho Foundry, Leeds, were showing Blake-Marsden jaw-breakers and the Mitchell vibrating screen. The former are well known to readers of the MAGAZINE, while the latter was described in some detail in the April issue.

Reavell and Co., Ltd., of Ipswich, in addition to examples of their portable air-compressors driven by both petrol and Diesel engines, had an example of their two-cylinder vertical single-acting compressor, which is of the same type as was described in the MAGAZINE for October last.

Petters, Ltd., of Yeovil, were showing a number of their smaller engines — paraffin, petrol, and Atomic Diesel. The latter have a fuel consumption of from 0·4 to 0·45 pints of fuel oil per b.h.p. per hour according to the size of the engine. Although no examples of the larger sizes were shown, the range goes up in the Diesel class to 540 b.h.p.

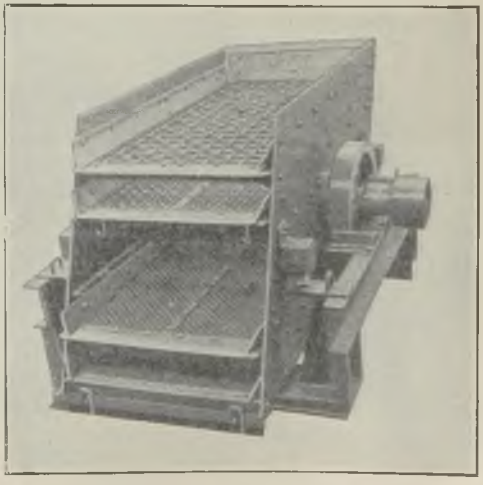
G. A. Harvey and Co. (London), Ltd., of Greenwich Metal Works, London, S.E. 7, had a representative exhibit of their woven wire and perforated metal products for screening of ore, coal, etc. There were also examples of their products in pressed steel and other metals, in which a variety of shapes are produced and among which may be included tanks of all shapes and sizes, stills, pressure vessels, cyclones, and hoppers.

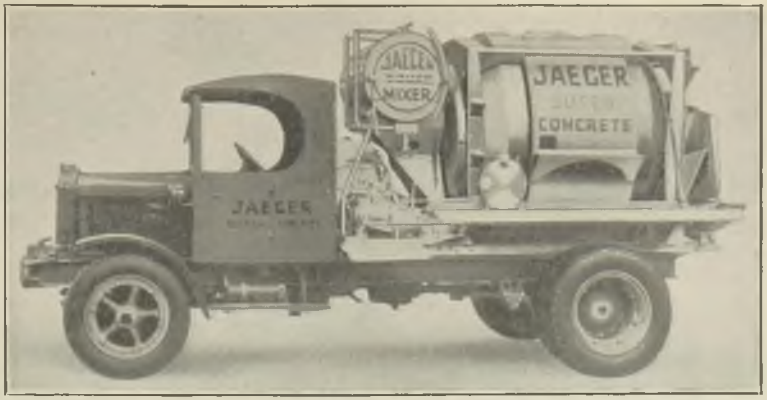
Huntington, Heberlein, and Co., Ltd., of 47–51, King William Street, London, E.C. 4, were showing their HH vibrating screens with two decks, in which a new method of mesh mounting has been adopted, and their HH jigger screen, also with two decks. This screen is mounted horizontally and thus forms a conveyor as well as a screen. Models are built in lengths up to 25 ft. The screen is actuated solely by means of an unbalanced pulley.

Ingersoll-Rand Co., Ltd., of 165, Queen Victoria Street, London, E.C. 4, were occupants of a large stand on which they were showing several types of air-compressors suitable for drive by either petrol or Diesel engines. They were also showing examples of their drills, including jackhammers and drifters, together with steel, hose, couplings, and other accessories. One of their No. 24 bench-type drill steel sharpeners was also on exhibit and an oil-fired furnace.

Nordberg Manufacturing Co., of Bush House, London, W.C. 2, exhibited a Symons cone crusher and by means of models and sections were demonstrating the relative merits of the Symons Short-Head crusher. In addition they had a number of samples of crushed material which demonstrated strikingly the even sizes of the product from both these types of crushers and the small percentage of fines produced. When it is remembered that these crushers are suitable for delivery of a feed to a ball- or tube-mill it will be appreciated how important is the uniformity of the product.

J. Darnley Taylor and Co. (1931), Ltd., of Grenade Street, London, E. 14, exhibited their Niagara roller-bearing vibrating screens, the essential feature of which is that the screen surface has a complete rotary motion. This is secured by the use of an eccentric shaft mounted centrally on the screen frame proper, which gives the screen a positive rotation with each revolution. The effect is that the material passing over the screen surface is constantly kept turning backwards whilst travelling down the surface. The screen is built in





RANSOMES AND RAPIER JAEGER TRUCK MIXER.

a number of sizes and with single decks or superimposed decks up to four, one of the single-deck variety being shown in the illustration.

Goodwin, Barsby, and Co., Ltd., of 12 Doughty Street, London, W.C. 1, had on view their patent lever-type jaw-breaker, for which it is claimed that the mechanism has been so balanced as to effect a great economy in power. Their Acme breaker is a similar product. Another crushing machine is of the rolls type, which is provided with a spring relief gear for safety. Manganese steel renewable shells are fitted. Other exhibits included a conveyor and portable loader, elevators, and vibrating screens, while by means of a model they demonstrated their Gravel-Winner, which consists of a chain of buckets having renewable manganese steel teeth and designed for removal of overburden.

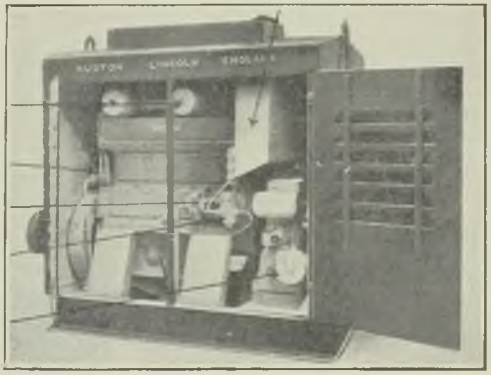
Atlas Diesel Co., Ltd., of New Oxford House, Hart Street, London, W.C. 1, were showing both portable and semi-portable air-compressors, one with a Diesel-engine drive and the other driven by electric motor. They were also showing a new drifter which is a cradle-mounted, screw-feed, automatic-rotation drill designed for heavy work in hard rock. Other drills shown included one with a reversing feed device for quick withdrawal of the steel from the hole, a hand hammer drill, a sinker for deep vertical holes, and a light hand pick. A drill sharpener and a pneumatic hoist completed the items of interest to mining men on this stand.

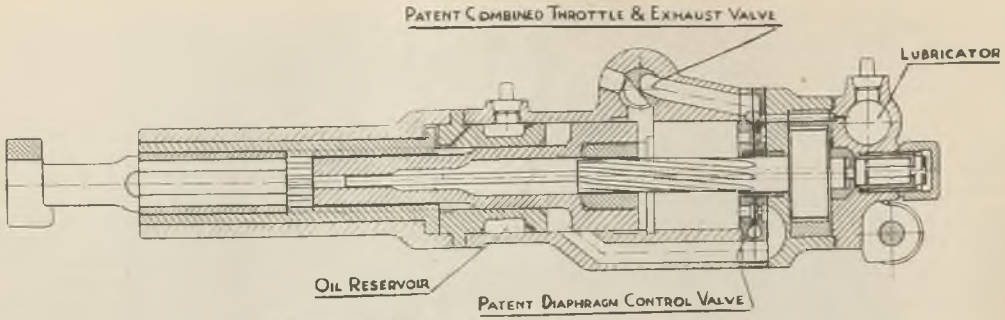
Ross Patents, Ltd., of Abbey House, Victoria Street, London, S.W. 1, were demonstrating by means of models their patent roll screen and the Ross patent feeder, both of which have been described in these columns in the issues for September, 1927, and September, 1931. The former, it will be recalled, consists essentially of two rolls, one having a smooth surface over which the material flows towards the aperture between the rolls and the other being formed of a serrated or rough surface which moves in an upward direction only (with relation to the screen apertures) and carries off the oversize material with a maximum of frictional grip.

Ransomes and Rapier, Ltd., of Ipswich, were showing a variety of their products, including concrete mixers, a mobile crane, and a Diesel locomotive. A new machine is the Jaeger truck concrete mixer, which is now being manufactured under licence for Jaeger Truck Mixers (England), Ltd. These are built in sizes from 1 to 5 cu. yd. and of two types, having end-discharge and side-discharge respectively. One of the range, which is illustrated, is the 1½-yd. end-discharge type which was exhibited mounted on a trailer. The mixer may be rotated with power from a separate unit or direct from the lorry engine. It has a number of special features that improve the quality of the product and increase the rate of production. The mixing starts from the moment the raw materials have been loaded on the machine and once the lorry is under way.

Holman Bros., Ltd., of Camborne, were occupants of a large stand on which they were exhibiting four sizes of portable air-compressors, three driven by Diesel engines and one having a petrol-engine power unit. They were also showing one stationary compressor direct-coupled to an electric motor—one of the firm's "S" type—a single-stage machine. A wide range of pneumatic tools, including those of the rock-drill type, was also shown and there were examples of two kinds of drill sharpener—the "Newgrip" and the "Twin-grip." There was also shown a Rotomill for hot milling. In addition there were one or two air-driven and electric-driven portable hoists for haulage work.

Ruston-Bucyrus, Ltd., and Ruston and Hornsby, Ltd., of Lincoln, were joint occupants of a stand on which were shown their crude-oil locomotive suitable for any quarry or open-cast mine haulage, which was described in the MAGAZINE for December, 1931, and a new transportable oil engine. This, as the illustration shows, consists of the





Armstrong Whitworth Jackhammer Drill

standard vertical VQ engine, together with starting air-compressor and other accessories mounted on and enclosed in a steel housing equipped with slings, whereby it may be lifted by a crane and deposited on the spot where it is required for work. The plant is made with 2, 3, 4, 5, and 6 cylinder engines and powers ranging from 32 to 96 b.h.p. at 1,000 r.p.m.

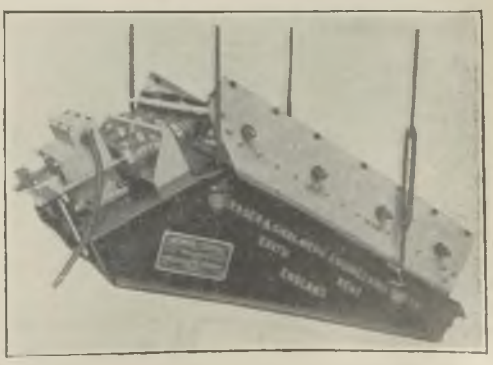
Thomas Locker and Co., Ltd., of Warrington, were showing screening and conveying equipment. Their vibrating screen was described in the Magazine for April, 1930, in which was also a brief reference to their vibrating conveyors. The latter, which were also shown at the exhibition, have a vibrating mechanism similar to that employed on

the screen, which is electrically-driven. Conveyors so operated are made in a variety of shapes and sizes for all classes of duties, ranging from 1 to 1,000 lb. per 24 hours in a small plant to 5 to 750 tons per hour in large installations. As well as open conveyors, they make a feature of tubular types suitable for conveying crushed material and similarly vibrated, which are illustrated.

Sir W. G. Armstrong Whitworth and Co. (Engineers), Ltd., of Newcastle-on-Tyne, made a special feature on their stand of pneumatic tools and a portable air-compressor. Among the former may be mentioned three types of jack-hammer drills for wet or dry drilling, which are a new product. The three types refer to three sizes, the respective weights of which are 30, 40, and 50 lb. and a cross-section of one is shown. The important feature is the main valve, which is described as being of unique construction and consists simply of a light flexible steel diaphragm rigidly held in position and having no sliding surfaces to wear. Another feature is the combined throttle and exhaust valve, which has three positions. In the first the air is shut off from the tool and the exhaust is closed, effectively preventing the ingress of dirt to the cylinder, in the second position the full drilling power is available and the exhaust is fully open, while in the third the air is shut off from the tool, the exhaust is closed, and air is fed straight through the centre of the tool for blowing out the hole.

Hadfields, Ltd., made a special feature on their stand of portable crushing and screening plant. These are made in various sizes and one unit consists of a 20 by 10 in. solid steel jaw-breaker and two revolving screens, one below the feeding platform and one overhead. The bottom one has a moderately fine mesh screen for separating the finer particles, while the top one has larger holes for grading the coarser stone. The crushed stone after passing along the bottom screen is carried to the top one by a bucket elevator. The use of "Era" manganese steel for wearing parts of crushing machinery was exemplified, as was the use of C.R. non-corrodible steel. Among other special exhibits may be mentioned "Hadmang" welding rods for use in welding manganese steel by either the electric arc or the oxy-acetylene process.

Fraser and Chalmers Engineering Works (Proprietors: The General Electric Co., Ltd.), of Erith, Kent, were showing vibrating screens of both Robins-Gyrex and Sherwen types, as well as a Robins portable conveyor. The Sherwen screen is of a new type. An early form of this screen was described in the Magazine for April, 1931. The present screen is also electrically-driven, the vibrations being obtained by the use of a Westinghouse half-wave metal rectifier connected in series with the vibrator coils. The cycle of operations begins with the rectified half-wave from the rectifier passing to the vibrator coils and drawing forward the armature, which is connected to the screen frame. During the other half-wave of the a.c. cycle the



current is prevented from passing to the coils, thus enabling the springs supporting the armature and live screen frame to accomplish the return stroke. A 50 a.c. supply transmits to the frame an intense vibration of 3,000 cycles per minute. As may be seen from the illustration, the vibrating unit is fixed at the back of the frame and away from the screen cloth, but it will be noticed that advantage is taken of this position to give the most intense vibration to the cloth at the feed-end. Similarly a gradual decrease in vibration towards the discharge-end is accomplished. The screen is made in standard sizes of from 3 by 5 ft. and 3 by 8 ft. and with single or double decks.

Climax Rock Drill and Engineering Works, Ltd., of 4, Broad Street Place, London, E.C.2, were showing a number of rock-drills and also drill sharpeners. Special attention may be directed to a new drill, which is the 3-in. disc-valve automatic stoper. The salient features of this are: The use of a bronze rotation nut and rifle nut. There are no springs and the cylinder is fully air-cushioned. A Linatex rubber washer, or annular ring, is inserted in the tool-holder to prevent cuttings and water from entering into the drill—the tool-holder also has a screwed bush. On the handle is an air release valve operated by push-button for regulating the pressure of the steel against the rock. The following are some dimensions and other figures: Length 5 ft. 3 in., length of feed 27½ in., size of steel 1 and 1¼ in. hex. and ⅞ and 1 in. quarter octagon. The air consumption at 80 lb. is 135 cu. ft. per min. and the net weight 116 lb. Two examples of their drill sharpeners were also shown. These are made in three sizes—the No. 2, No. 1, and "S" type. The first is designed to make bits up to 4 in. in diameter, the second for bits not exceeding 3 in. in diameter, and the "S" type, which has been specially constructed to supply the needs of the smaller mine or where jackhammers are used, is for bits not exceeding 2⅝ in. in diameter and will make all types of bits and shanks. The air consumption of the first two is about 100 cu. ft. per min. at 80 lb. pressure, but in the case of the smaller machine it does not usually exceed 55 cu. ft.

METAL MARKETS

Copper.—The standard copper market was dull and easy during November, when prices lost a fair amount of ground. Uncertainties connected with the dollar have helped to push values downwards and it has become fairly clear that a cheap dollar entails lower rather than higher copper prices on the international market. Industrial demand for copper was quiet. The American domestic quotation for electrolytic kept fairly steady between 8·00 and 8·25 cents per lb. delivered. The export price had a downward trend, on the whole, and closed November at 7·75 cents c.i.f. Europe.

Average price of Cash Standard Copper: November, 1933, £30 12s. 6d.; October, 1933, £33 13s. 10d.; November, 1932, £32 0s. 4d.; October, 1932, £31 18s. 7d.

Tin.—This market presented a fairly steady aspect during November. The statistical position continued to improve, but on the other hand American buying was not heavy and, as deliveries of tin in the United States are now receding, the immediate outlook as regards fresh large-scale transatlantic purchases is not very brilliant. Market supplies are, however, likely to grow more stringent between now and the beginning of 1934, when a bigger output is authorized by the Tin Restriction authorities, but it remains to be seen whether this fact will result in firmer prices. Portugal and French Indo-China have joined the restriction scheme and preliminary negotiations have been entered into with the Belgian Congo producers. The latter, however, are unlikely to join unless they receive exceptionally favourable terms.

Average price of Cash Standard Tin: November, 1933, £226 16s. 3d.; October, 1933, £223 10s. 7d.; November, 1932, £153 13s. 3d.; October, 1932, £151 7s. 6d.

Lead.—Apart from a spurt that occurred early in November owing to strike trouble at Mount Isa and Broken Hill South and which was very short-lived, the London lead market presented a colourless aspect last month. Consumption in this country is well maintained, but on the Continent it leaves much to be desired. That conditions in the United States are not as good as might be wished is indicated by the latest expansion in stocks there and the decline in the price at the close of November from 4·30 cents to 4·15 cents per lb. New York. The world situation of lead is overshadowed by the continued existence of very large stocks.

Average mean price of soft foreign lead: November, 1933, £11 13s. 1d.; October, 1933, £11 19s.; November, 1932, £12 4s. 7d.; October, 1932, £12 1s. 3d.

Spelter.—Prices recorded a loss last month, sentiment being affected by uncertainties regarding Cartel developments. The market is anxious to discover whether producers will actually decide to restrict production further to 45% of the agreed basis so as to prevent stocks from increasing. Meanwhile industrial demand is quiet.

Average mean price of spelter: November, 1933, £15 3s. 11d.; October, 1933, £16 9s. 1d.; November, 1932, £15 7s. 11d.; October, 1932, £15 0s. 1d.

Iron and Steel.—Cheerful conditions continued to prevail on the British pig-iron market during November. Makers are taking steps to increase output and are in most cases well booked, although of course one must remember that only a fraction of the available furnaces are working. No. 3 Cleveland foundry pig-iron remained at 62s. 6d. delivered Middlesbrough. Hematite is a better market than it was owing to the agreement recently arrived at between makers and the improved demand. The position on the British semi-finished and finished steel market has improved, partly owing to the better outlook in the shipbuilding industry. The Continental Steel Cartel continued to struggle along against difficulties but it does not appear likely to break up just yet.

Iron Ore.—Quite a good tone was seen in this market during November—at any rate, as far as home trade business was concerned. More furnaces were lit and consumption increased. On the Continent the situation is not quite as satisfactory, but there are signs of improvement. Best Bilbao rubio is quoted at about 16s. to 16s. 3d. per ton c.i.f., with good North African ores 14s. to 15s. c.i.f. according to quality.

Antimony.—Dull conditions have ruled and although for a time sellers were firm in their ideas, prices subsequently eased to about £21 15s. c.i.f. for forward shipment from China. English regulus ex warehouse is still quoted at £37 10s. to £40 per ton.

Arsenic.—Demand is rather slow, but Cornish

LONDON DAILY METAL PRICES.

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

	COPPER.				TIN.		ZINC (Spelter).	LEAD.		SILVER.		GOLD
	Standard.		Electro-lytic	Best Selected.				Soft Foreign.	English.	Cash.	Forward.	
	Cash.	3 Months.			Cash.	3 Months.						
Nov.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
13	31 15 0	31 18 9	35 10 0	—	229 18 9	228 17 6	15 5 0	11 13 9	13 5 0	18⅝	18⅝	129 1½
14	31 5 7½	31 8 1½	34 15 0	33 15 0	229 16 3	228 16 3	15 0 0	11 10 0	13 0 0	18⅝	18 11/16	128 7
15	29 8 1½	29 11 10½	33 10 0	—	226 17 6	226 7 6	14 10 0	11 0 0	12 10 0	18½	18⅝	129 0½
16	28 15 7½	28 18 1½	32 5 0	—	226 17 6	226 8 9	14 12 6	11 2 6	12 10 0	18⅝	18¾	128 6
17	29 13 9	29 16 10½	33 10 0	32 5 0	226 16 3	226 7 6	15 0 0	11 8 9	12 15 0	18⅝	18 7/16	128 2
20	29 5 7½	29 8 1½	33 0 0	—	227 17 6	227 13 9	14 16 3	11 5 0	12 15 0	18⅝	18⅞	127 7
21	29 6 10½	29 10 7½	33 0 0	32 0 0	227 16 3	227 13 9	14 10 0	11 3 9	12 15 0	18⅝	18½	127 0
22	29 8 1½	29 10 7½	32 17 6	—	227 8 9	227 8 9	14 8 9	11 3 9	12 15 0	18⅝	18⅞	126 6
23	29 6 10½	29 9 4½	33 0 0	—	227 2 6	227 2 6	14 7 6	11 7 6	12 15 0	18½	18⅝	125 8
24	29 6 10½	29 9 4½	33 0 0	32 0 0	226 2 6	226 2 6	14 10 0	11 10 0	12 15 0	18⅞	18½	126 1
27	29 15 7½	29 18 1½	33 5 0	—	226 1 3	226 1 3	14 12 6	11 11 3	13 0 0	18⅝	18⅞	125 3½
28	30 3 1½	30 6 10½	33 15 0	32 10 0	225 13 9	225 13 9	14 17 6	11 11 3	13 0 0	18⅝	18⅝	125 6
29	29 11 10½	29 15 7½	33 5 0	—	225 11 3	225 13 9	14 15 0	11 11 3	13 0 0	18⅝	18½	125 6
30	29 11 10½	29 14 4½	32 17 6	—	225 13 9	225 16 3	14 16 3	11 8 9	13 0 0	18⅜	18⅝	125 1½
Dec.												
1	29 11 3	29 15 0	32 17 6	31 15 0	226 3 9	226 6 3	14 12 6	11 8 9	13 0 0	18⅝	18⅞	125 2
4	29 18 1½	30 0 7½	33 0 0	—	227 13 9	227 13 9	14 13 9	11 11 3	13 0 0	18⅞	18⅝	124 8
5	30 3 1½	30 5 7½	33 7 6	32 5 0	227 3 9	227 6 3	14 16 3	11 11 3	13 0 0	18⅝	18⅜	125 6
6	30 3 9	30 4 4½	33 7 6	—	227 6 3	227 6 3	14 17 6	11 12 6	13 0 0	18⅜	18 11/16	126 11
7	30 2 6	30 4 4½	33 2 6	—	226 11 3	226 13 9	14 16 3	11 8 9	13 0 0	18 11/16	18 11/16	126 0
8	30 2 6	30 5 0	33 10 0	32 5 0	227 8 9	227 8 9	14 17 6	11 8 9	13 0 0	18⅞	18⅜	126 9
11	30 7 6	30 10 7½	33 15 0	—	228 8 9	228 8 9	14 15 0	11 8 9	13 0 0	18⅞	18 11/16	127 0

white is upheld at £16 to £16 5s. per ton f.o.r. mines, with Mexican high-grade about £16 c.i.f. Continental material is occasionally offered cheaper.

Bismuth.—The official price was raised during November to 5s. 6d. per lb. for 5-cwt. lots and over, at which level a fair business is reported.

Cadmium.—There has been a fairly good demand in this country and prices have been maintained at 1s. 2d. to 1s. 2½d. per lb. for average parcels.

Cobalt Metal.—With additional supplies available and only a limited demand prices have been reduced to 4s. 6d. per lb. for cwt. lots.

Cobalt Oxides.—At present quotations are maintained, despite the fall in metal. Black stands at 4s. 6d. to 4s. 8d. per lb. and grey at 4s. 9d. to 4s. 11d.

Chromium.—The price remains at 2s. 8d. per lb. delivered, business being moderate.

Tantalum.—About £15 per lb. is still quoted.

Platinum.—Early in the month there was more demand, but later rather quiet conditions ensued. Prices are steady at £7 12s. 6d. to £7 15s. per oz. for refined metal.

Palladium.—The market is without special feature at the unaltered prices of £3 10s. to £4 5s. per oz.

Osmium.—Quotations are upheld at £12 to £13 per oz. for the limited quantities that are in demand.

Iridium.—Demand is slow, but prices remain at £9 to £10 per oz. for sponge and powder.

Tellurium.—A fair business is passing, with minimum 14-lb. lots of ingots quoted at 15s. to 16s. per lb.

Selenium.—Around 7s. 6d. to 7s. 8d. per lb. ex warehouse Liverpool remains the current price of high-grade black powder.

Manganese Ore.—More interest has been shown by buyers, including some inquiry from Japan. Actual business, however, has not been important. Prices remain at about 9½d. per unit c.i.f. for best Indian and 9d. c.i.f. for washed Caucasian ore.

Aluminium.—The demand for raw aluminium in this country is fairly good, showing some improvement during recent weeks. Prices, however, remain unaltered at £100 for ingots and bars and £102 for rolling billets, both less 2% delivered.

Sulphate of Copper.—Prices are easier in sympathy with the decline in standard copper, English material being quoted at £15 5s. to £15 15s. per ton, less 5%.

Nickel.—Business remains fairly brisk, with prices unaltered at £225 to £230 per ton, according to quantity.

Chrome Ore.—Although demand shows an improving tendency, the general level of business is still rather unsatisfactory, but prices remain at 80s. to 85s. per ton c.i.f. for first quality 48% Rhodesian ore and 100s. to 105s. c.i.f. for 55 to 57% New Caledonian.

Quicksilver.—The market has been featureless, with prices around £9 15s. per bottle, net, for spot metal.

Tungsten Ore.—This has remained an erratic market, a wide spread existing at times between buyers' and sellers' ideas of price. It is now reported that a Government export monopoly may be imposed in China. Ore for forward shipment is quoted at about 28s. per unit c.i.f., but second-hand parcels have been offered at less. At the moment, however, buyers' ideas are only about 25s. to 25s. 6d. per unit c.i.f.

Molybdenum Ore.—A quiet business continues at around 40s. to 42s. 6d. per unit c.i.f. for good standard concentrates.

Graphite.—A fair demand continues at the unaltered prices of £19 to £21 per ton duty paid for 85 to 90% Madagascar flake and £15 to £17 c.i.f. for 90% Ceylon lumps.

Silver.—With spot bars at 18 5/16d. on November 1 India and China offered resistance to American and Continental selling. Later the easiness of the dollar led to some American buying and by November 14 spot bars were 18 5/16d. In the latter part of the month American inquiry tailed off and a little selling emanated from that quarter. A small demand sprang up from India and, after touching 18¼ on the 23rd, spot bars closed on November 30 at 18⅜d.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
November, 1932	930,085	48,631	978,716
December	931,749	48,869	980,618
January, 1933	919,125	48,332	967,457
February	835,931	47,214	883,145
March	896,728	50,135	946,863
April	845,099	49,998	895,097
May	893,464	51,140	944,604
June	868,834	49,799	918,633
July	872,695	50,976	923,671
August	882,587	52,127	934,714
September	851,985	49,814	901,799
October	856,724	52,164	908,888
November	847,412	51,056	898,468

TRANSVAAL GOLD OUTPUTS.

	October.*		November.†	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	117,000	£237,458	122,500	£240,518
City Deep	111,000	22,024	104,500	21,018
Cons. Main Reef	84,000	23,513	83,000	23,622
Crown Mines	300,000	88,511	290,000	85,605
Daggafontein	60,300	£138,895	63,500	£142,469
D'rb'n Roodepoort Deep	53,600	13,844	52,000	13,383
East Geduld	79,000	26,480	79,000	26,479
East Rand P.M.	174,000	40,812	170,000	40,144
Geduld	91,800	26,984	88,500	26,073
Geldenhuis Deep	83,000	14,757	81,000	14,347
Glynn's Lydenburg	7,600	3,477	7,500	2,969
Government G.M. Areas	208,000	£536,562	208,000	£518,289
Kleinfontein	48,700	9,113	52,200	9,519
Langlaagte Estate	83,000	£116,089	81,000	£112,264
Luipaard's Vlei	37,000	8,391	36,000	8,106
Modderfontein New	177,000	49,294	176,000	48,856
Modderfontein B	82,000	17,636	81,000	17,020
Modderfontein Deep	45,500	17,074	45,600	16,881
Modderfontein East	78,000	20,330	79,000	20,262
New State Areas	91,000	£253,274	91,000	£242,470
Nourse	72,000	17,719	71,000	17,432
Randfontein	280,000	£441,309	270,000	£413,871
Robinson Deep	100,000	£172,553	100,000	£165,945
Rose Deep	65,000	11,771	63,000	11,798
Simmer and Jack	90,000	£132,801	89,300	£130,225
Springs	84,500	£233,156	84,500	£226,009
Sub Nigel	42,400	£231,744	41,000	£221,834
Transvaal G.M. Estates	20,700	5,422	20,100	5,622
Van Ryn	54,000	£60,933	53,000	£57,541
Van Ryn Deep	79,000	£126,533	78,000	£123,752
West Rand Consolidated	98,000	£154,846	97,000	£149,452
West Springs	87,500	£102,411	88,500	£101,273
Witw'tersr'nd (Knights)	76,000	£79,639	76,000	£76,456
Witwatersrand Deep	51,500	£67,612	51,000	£66,401

* [Gold at 129s. per oz.] † [Gold at 125s. per oz.]

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.	£
August, 1932	3,027,700	27 6	19 0	8 5	1,277,923
September	2,940,800	27 6	19 1	8 5	1,234,584
October	2,994,500	27 5	19 1	8 5	1,263,274
November	2,949,050	27 8	19 0	8 5	1,256,717
December	2,972,000	27 10	19 2	8 6	1,255,797
January, 1933	3,029,000	27 10	19 5	8 5	2,802,754
February	2,802,600	27 0	19 4	18 6	2,414,758
March	3,087,860	36 1	19 9	17 3	2,549,179
April	2,922,200	36 1	19 7	16 6	2,381,971
May	3,144,600	35 8	19 9	16 4	2,556,066
June	3,093,500	35 4	19 5	16 3	2,453,205
July	3,182,600	35 5	19 6	15 10	2,568,899
August	3,221,850	35 9	19 3	16 2	2,651,880
September	3,152,700	36 5	19 5	17 0	2,684,772
October	3,212,100	36 1	19 4	16 9	2,693,333

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
November 30, 1932	219,024	11,353	—	227,651
December 31	221,008	11,207	—	230,231
January 31, 1933	222,005	11,310	—	232,318
February 28	222,589	11,292	—	233,297
March 31	223,490	11,472	—	234,061
April 30	225,279	11,626	—	235,116
May 31	227,178	11,611	—	236,890
June 30	229,751	11,562	—	238,740
July 31	230,306	12,059	—	241,810
August 31	231,341	12,269	—	242,575
September 30	230,774	11,947	—	243,288
October 31	231,799	11,832	—	242,606
November 30	233,657	11,744	—	245,401

PRODUCTION OF GOLD IN RHODESIA.

	1930	1931	1932	1933
	oz.	oz.	oz.	oz.
January	46,121	45,677	42,706	48,656
February	43,385	42,818	45,032	47,661
March	45,511	42,278	47,239	49,929
April	45,806	43,776	46,487	53,559
May	47,645	43,731	46,854	53,358
June	45,208	44,118	48,441	54,442
July	45,810	44,765	47,331	54,561
August	46,152	43,292	49,254	56,147
September	46,151	42,846	50,198	56,790
October	45,006	44,260	50,416	55,196
November	44,351	44,516	48,082	—
December	46,485	50,034	52,096	—

RHODESIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	25,800	8,916	25,400	8,875
Globe and Phœnix	6,090	5,430	6,040	5,356
Lonely Reef	14,000	1,855	13,600	1,852
Rezende	6,500	2,019	6,500	£7,938
Sherwood Star	7,000	£12,358	7,000	2,008
Wanderer Consolidated	16,100	3,361	15,600	3,314

WEST AFRICAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	9,278	£26,144	9,480	£25,647
Ashanti Goldfields	13,622	14,829	13,650	14,831
Taquah and Abosso	12,107	4,105	11,405	3,840

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
November, 1932	53,956	—	4,386
December	52,282	38,612†	4,602
January, 1933	45,755	—	4,005
February	47,281	—	4,365
March	47,105	—	4,758
April	52,909	—	12,460
May	53,300	—	7,135
June	53,451	27,593*	7,699
July	54,455	7,963	6,774
August	56,147	3,926	7,750
September	58,679	—	—
October	54,834	—	—
November	58,009	—	—

* Six months to June 30. † Period Jan.–Nov., 1932.

AUSTRALASIAN GOLD OUTPUTS.

	October.		November.	
	Tons.	Value £	Tons.	Value £
Associated G.M. (W.A.)	4,824	7,372	4,701	5,149
Blackwater (N.Z.)	3,797	1,679*	4,185	1,859*
Boulder Persev'ce (W.A.)	7,606	5,967*p*	7,202	6,824*p*
Grt. Boulder Pro. (W.A.)	6,331	5,143*	6,792	5,037*
Lake View & Star (W.A.)	41,744	86,368	37,614	67,681
Sons of Gwalia (W.A.)	12,260	15,070	12,200	3,670*
South Kalgurli (W.A.)	10,226	12,671	9,677	12,327
Waihi (N.Z.)	16,355	{ 4,744* / { 34,863†	18,791	{ 6,150* / { 41,691†
Wiluna	42,015	11,075*	—	—

* Oz. gold. † Oz. silver. *p* Profit

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	October.		November.	
	Tons Ore.	Total Oz.	Tons Ore.	Total Oz.
Champion Reef	10,200	5,307	10,040	5,307
Mysore	15,240	7,847	15,010	7,729
Nundydroog	17,985	9,611†	18,000	9,905*
Ooregum	12,504	4,329	12,005	4,141

* 861 oz. from 959 tons Balaghat ore.
† 906 oz. from 756 tons Balaghat ore.

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	October.		November.	
	Tons.	Value £	Tons.	Value £
Bulolo Gold	—	8,100*	—	—
Chosen Corp. (Korea)	12,700	17,802	12,270	17,157
Frontino Gold (C'lbia)	4,720	19,025	4,920	18,447
Fresnillo	84,162	68,160*d*	—	—
New Goldfields of Venezuela	15,283	4,610*	14,875	5,280*
Oriental Cons. (Korea)	—	85,635*d*	—	73,640*d*
St. John del Rey (Brazil)	—	32,500	—	36,000
Santa Gertrudis (Mexico)	12,346	11,400*d*†	—	—
Viborita	—	—	—	—
West Mexican Mines	2,250	22,000*d*	—	—

* Oz. *d* Dollars. † Loss.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

January, 1933	2,312	July, 1933	2,446
February	2,154	August	1,816
March	1,506	September	1,335
April	2,589	October	2,436
May	1,917	November	1,800
June	1,092	December	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Ayer Hitam	—	—	—
Batu Caves	—	63	—
Changkat	36	27	30
Gopeng	60½*	—	—
Hongkong Tin	74*	—	—
Idris Hydraulic	—	10½	—
Ipoh	15	40	44
Kampar Malaya	—	—	—
Kampong Lanjut	—	—	—
Kamunting	75	110½	95½
Kent (F.M.S.)	—	—	—
Killinghall	76½*	—	—
Kinta	28½*	—	—
Kinta Kellas	—	—	—
Kramat Tin	40	55	55
Kuala Kampar	46	44	60
Kundang	—	—	—
Lahat	10¾	12	11½
Lower Perak	—	—	—
Malaya Consolidated	136	—	—
Malayan Tin	27½	53½	59½
Malim Nawar	23	20	18
Pahang	78	78	78
Penawat	32	37½	31
Pengkalen	55½*	—	—
Petaling	—	222	—
Rahman	—	—	—
Rambutan	—	—	—
Rantau	—	37½	—
Rawang	60	45	27
Rawang Concessions	30	25	25
Renong	—	27	23¾
Selayang	—	—	—
Southern Kampar	—	116¾	16
Southern Malayan	71½	62½	71½
Southern Perak	—	32½	24½
Southern Tronoh	—	—	—
Sungei Besi	—	—	—
Sungei Kinta	—	—	—
Sungei Way	—	—	—
Taiping	—	19	—
Tanjong	—	—	—
Tekka	39*	—	—
Tekka Taiping	54½*	—	—
Temoh	13¾	14½	21½
Tronoh	—	—	—
Ulu Klang	26*	—	—

* 3 months to September 30.

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Anglo-Nigerian	16	16	23
Associated Tin Mines	100	105	105
Baba River	8	10	—
Batura Monguna	—	—	—
Bisichi	17	20	—
Daffo	—	—	—
Ex-Lands	23	22	24
Filani	—	—	—
Jantar	8½	10	10
Jos	8	7¾	—
Juga Valley	5½	5½	5½
Kaduna Syndicate	10	10	—
Kaduna Prospectors	7	7	—
Kassa	4	4	6
London Tin	76	70	76
Lower Bisichi	3	3	—
Naraguta Extended	—	—	—
Nigerian Consolidated	5	5	5
Offin River	—	—	—
Ribon Valley	6	7	7
Tin Fields	—	—	—
United Tin Areas	6	5	7
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Sept.	Oct.	Nov.
Anglo-Burma (Burma)	41	41	—
Aramayo Mines (Bolivia)	118	101	100
Bangrin (Siam)	44½	52½	59
Beralt	34*	40*	45*
Consolidated Tin Mines (Burma)	100	80	67
East Pool (Cornwall)	49½	49½	50
Fabulosa (Bolivia)	25	21	—
Geevor	59½	55	63
Kagera (Uganda)	25	25	—
Kamra	17½	23½	37
Malaysiam Tin	14½	14½	14½
Mawchi	264½*	284½*	—
Patino	—	—	—
Pattani	66½	125½	21½
San Finx (Spain)	—	—	—
Siamese Tin (Siam)	130	117	129
South Crofty	53½	53½	53
Southern Siamese	—	—	12¾
Tavoy Tin (Burma)	86	95	76
Tongkah Harbour (Siam)	32	45	54
Toyo (Japan)	62	81½	82½
Zaaiplaats	12½	—	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Oct.	Nov.
Britannia Lead	Tons refined lead	4,732	3,916
	Oz. refined silver	187,682	218,122
Broken Hill South	Tons lead conc.	2,762*	5,169
	Tons zinc conc.	3,125*	5,475
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	470,627	480,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	400	400
	Tons yellow metal	489	464
Messina	Tons copper	754	699
Mount Isa	Tons lead bullion	3,581	—
Mount Lyell	Tons concentrates	3,946	3,630
North Broken Hill	Tons lead conc.	5,630	6,400
	Tons zinc conc.	4,770	5,480
Rhodesia Broken Hill	Tons Zinc	1,680	1,540
	Tons V_2O_5 conc.	—	—
Roan Antelope	Tons blister copper	—	—
Sulphide Corporation	Tons lead conc.	1,576*	—
	Tons zinc conc.	2,494*	—
Trepca	Tons lead conc.	5,284	5,070
	Tons zinc conc.	7,629	7,795
Zinc Corporation	Tons lead conc.	5,630‡	—
	Tons zinc conc.	4,578‡	—

* To Nov. 4. ‡ To Nov. 11.

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

		Sept.	Oct.
Iron Ore	Tons	226,606	250,683
Manganese Ore	Tons	9,496	11,279
Iron and Steel	Tons	80,342	88,854
Copper and Iron Pyrites	Tons	22,236	20,925
Copper Ore, Matte, and Prec.	Tons	4,369	3,984
Copper Metal	Tons	11,493	15,445
Tin Concentrate	Tons	943	2,493
Tin Metal	Tons	185	426
Lead Pig and Sheet	Tons	21,469	22,436
Zinc (Spelter)	Tons	5,802	7,012
Zinc Sheets, etc.	Tons	1,771	1,833
Zinc Oxide	Tons	66	80
Zinc Ore and Conc.	Tons	22,240	10,962
Aluminium	Cwt.	16,106	28,955
Mercury	Lb.	46,270	102,100
White Lead	Cwt.	7,462	6,407
Barytes, ground	Cwt.	20,975	22,954
Asbestos	Tons	2,155	2,251
Boron Minerals	Tons	744	1,277
Borax	Cwt.	15,500	9,600
Basic Slag	Tons	—	—
Superphosphates	Tons	550	1,782
Phosphate of Lime	Tons	30,495	43,946
Mica	Tons	176	321
Tungsten Ores	Tons	436	335
Sulphur	Tons	3,805	6,544
Nitrate of Soda	Cwt.	—	—
Potash Salts	Cwt.	425,579	547,717
Petroleum: Crude	Gallons	32,051,008	28,509,470
Lamp Oil	Gallons	13,114,300	11,711,832
Motor Spirit	Gallons	98,730,827	87,332,531
Lubricating Oil	Gallons	11,071,837	12,855,654
Gas Oil	Gallons	7,917,118	5,864,332
Fuel Oil	Gallons	55,722,866	57,387,043
Asphalt and Bitumen	Tons	4,627	7,393
Paraffin Wax	Cwt.	69.641	75.226

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	Sept.	Oct.	Nov.
Anglo-Ecuadorian	17,099	17,416	16,493
Anglo-Persian	587,000	650,000	—
Apex Trinidad	41,280	44,370	45,140
Attock	1,035	1,118	1,160
British Burmah	—	3,948	3,832
British Controlled	25,841	29,217	25,979
Kern Mex.	551	758	782
Kern River (Cal.)	2,232	2,377	3,097
Kern Romana	168	312	363
Kern Trinidad	3,468	3,874	3,906
Lobitos	21,518	21,824	21,734
Phœnix	57,144	52,646	50,071
St. Helen's Petroleum	4,020	4,128	4,172
Steaua Romana	100,357	105,044	98,078
Tampico	1,616	1,981	2,200
Tocuyo	968	872	587
Trinidad Leaseholds	32,550	33,850	32,050

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Nov. 10, 1933.	Dec. 10, 1933.
	£ s. d.	£ s. d.
Anglo-Ecuadorian	16 6	14 0
Anglo-Egyptian B	1 13 0	10 6
Anglo-Persian 1st Pref.	1 12 6	1 12 3
" " Ord.	2 11 9	2 6 9
Apex Trinidad (5s.)	1 9 3	1 9 3
Attock	13 0	11 9
British Burmah (8s.)	4 3	3 6
British Controlled ($5)	5 9	5 0
Burmah Oil	4 10 6	4 5 0
Kern River Cal. (10s.)	5 3	3 6
Lobitos, Peru	2 9 3	2 3 0
Mexican Eagle, Ord. (4 pesos)	12 0	10 6
" " 8% Pref. (4 pesos)	12 0	11 3
Phœnix, Roumanian	13 6	12 0
Royal Dutch (100 fl.)	22 0 0	21 15 0
Shell Transport, Ord.	2 14 3	2 11 3
" " 5% Pref. (£10)	12 0 0	12 5 0
Steaua Romana	12 9	11 6
Trinidad Leaseholds	3 13 9	3 8 9
United British of Trinidad (6s. 8d.)	6 3	5 6
V.O.C. Holding	1 14 3	1 12 6

PRICES OF CHEMICALS. Dec. 11.

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

		£ s. d.
Acetic Acid, 40%	per cwt.	1 0 9
" " 80%	"	1 18 5
" " Glacial	per ton	59 0 0
Alum	"	8 7 6
Aluminium Sulphate, 17 to 18%	"	6 15 0
Ammonium, Anhydrous	per lb.	1 1
" 0·880 solution	per ton	15 10 0
" Carbonate	"	27 10 0
" Nitrate (British)	"	16 0 0
" Phosphate (Mono- and Di-)	"	58 0 0
" Sulphate, 20·6% N.	"	7 0 0
Antimony, Tartar Emetic, 43/44%	per lb.	10
" Sulphide, golden	"	9
Arsenic, White (foreign)	per ton	16 10 0
Barium, Carbonate (native), 94%	"	4 10 0
" Chloride	"	10 0 0
Barytes	"	8 5 0
Benzol, standard motor	per gal.	1 5
Bleaching Powder, 35% Cl.	per ton	8 15 0
Borax	"	16 10 0
Boric Acid	"	26 10 0
Calcium Chloride, solid, 70/75%	"	5 5 0
Carbolic Acid, crude 60's	per gal.	2 4
" " crystallized, 40°	per lb.	8½
Carbon Disulphide	per ton	30 0 0
Citric Acid	per lb.	9½
Copper Sulphate	per ton	15 5 0
Creosote Oil (f.o.b. in Bulk)	per gal.	4½
Cresylic Acid, 99–100%	"	1 5
Hydrofluoric Acid, 59/60%	per lb.	6
Iodine Resub. B.P. (28 lb. lots)	"	9 3
Iron, Nitrate 80° Tw.	per ton	6 10 0
" Sulphate	"	2 0 0
Lead, Acetate, white	"	34 0 0
" Nitrate (ton lots)	"	27 10 0
" Oxide, Litharge	"	27 0 0
" White	"	36 10 0
Lime, Acetate, brown	"	11 5 0
" " grey, 80%	"	16 10 0
Magnesite, Calcined	"	9 10 0
Magnesium Chloride	"	6 10 0
" Sulphate, comml.	"	5 0 0
Methylated Spirit Industrial 61 O.P.	per gal.	2 0
Nitric Acid, 80° Tw.	per ton	21 10 0
Oxalic Acid	per ton	48 15 0
Phosphoric Acid. (Conc. 1·750)	per lb.	10
Pine Oil	per cwt.	2 7 6
Potassium Bichromate	per lb.	5
" Carbonate, 96/98%	per ton	29 10 0
" Chlorate	per lb.	4½
" Chloride, 80%	per ton	9 10 0
" Ethyl Xanthate	per 100 kilos	7 8 0
" Hydrate (Caustic) 88/90%	per ton	39 0 0
" Nitrate	"	31 10 0
" Permanganate	per lb.	8½
" Prussiate, Yellow	per ton	75 0 0
" " Red	per lb.	2 0
" Sulphate, 90%	per ton	10 10 0
Sodium Acetate	"	22 0 0
" Arsenate, 45%	"	23 0 0
" Bicarbonate	"	10 10 0
" Bichromate	per lb.	4
" Carbonate (Soda Ash), 58%	per ton	6 0 0
" " (Crystals)	"	5 2 6
" Chlorate	"	32 0 0
" Cyanide, 100% NaCN basis	per lb.	8
" Ethyl Xanthate	per 100 kilos	7 0 6
" Hydrate, 76/77%	per ton	14 0 0
" Hyposulphite, comml.	"	9 2 6
" Nitrate (refined)	"	7 15 0
" Phosphate, comml.	"	11 5 0
" Prussiate	per lb.	4½
" Silicate	per ton	9 10 0
" " (liquid, 140° Tw.)	"	8 10 0
" Sulphate (Glauber's Salt)	"	2 15 0
" " (Salt-Cake)	"	3 3 6
" Sulphide, Conc., 60/65%	"	10 15 0
" Sulphite, pure	per cwt.	14 0
Sulphur, Flowers	per ton	9 2 6
" Roll	"	9 2 6
Sulphuric Acid 168° Tw.	"	4 5 0
" " free from Arsenic, 140° Tw.	"	3 0 0
Superphosphate of Lime (S.P.A. 16%)	"	3 4 0
Tartaric Acid	per lb.	1 0½
Turpentine	per ton	44 10 0
Tin Crystals	per lb.	1 6
Titanous Sulphate (Stabilized)	"	9
Zinc Chloride	per ton	9 10 0
" Dust, 90/92%	"	20 0 0
" Oxide (White Seal)	"	30 0 0
" Sulphate	"	9 0 0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Nov. 10, 1933. £ s. d.	Dec. 11, 1933. £ s. d.
SOUTH AFRICA:		
Brakpan	6 0 0	5 16 3
City Deep	1 15 0	1 10 6
Consolidated Main Reef	2 4 3	2 4 3
Crown Mines (10s.)	9 12 6	9 7 6
Daggafontein	4 12 6	4 14 3
Durban Roodepoort Deep (10s.)	1 18 9	1 17 6
East Geduld	6 17 6	6 15 0
East Rand Proprietary (10s.)	1 16 9	1 17 6
Geduld	6 16 3	6 13 9
Geldbenhuis Deep	1 8 0	1 8 9
Glynn's Lydenburg	1 15 0	1 15 0
Government Gold Mining Areas (5s.)	2 16 3	2 16 9
Grootvlei	3 15 0	3 15 0
Langlaagte Estate	1 9 0	1 8 6
Luipaard's Vlei (2s.)	12 3	11 6
Modderfontein, New (10s.)	3 5 6	3 6 9
Modderfontein B (5s.)	1 1 0	1 1 3
Modderfontein Deep (5s.)	1 1 6	1 2 6
Modderfontein East	2 18 9	2 18 9
New Kleinfontein	1 10 9	1 10 9
New State Areas	3 0 0	2 18 9
Nourse	1 18 9	1 17 6
Randfontein	2 15 0	2 12 6
Robinson Deep A (1s.)	13 9	13 9
" " B (7s. 6d.)	1 13 9	1 13 9
Rose Deep	1 0 9	1 1 3
Simmer and Jack (2s. 6d.)	11 3	10 9
Springs	5 8 9	5 7 6
Sub Nigel (10s.)	9 8 9	9 5 0
Van Ryn	1 6 9	1 6 9
Van Ryn Deep	1 18 9	1 17 6
Village Deep (9s. 6d.)	1 0	2 3
West Rand Consolidated (10s.)	1 3 6	1 3 0
West Springs	1 15 0	1 14 3
Witwatersrand (Knights)	1 6 3	1 6 9
Witwatersrand Deep	1 8 0	1 11 3
RHODESIA:		
Cam and Motor	2 11 9	2 10 6
Globe and Phœnix (5s.)	1 2 6	1 4 0
Lonely Reef	15 0	12 6
Luiri Gold (Priority)	2 4	2 4
Rezende (17s. 6d.)	1 8 9	1 12 6
Sherwood Starr (5s.)	12 6	11 6
Wanderer	17 6	17 6
GOLD COAST:		
Ariston (2s. 6d.)	8 3	8 0
Ashanti (4s.)	2 7 6	2 13 3
Taquah and Abosso (4s.)	16 0	15 6
AUSTRALASIA:		
Associated Gold (4s.), W.A.	4 6	4 3
Boulder Perseverance	3 2	2 9
Gold Mines of Australia	9 3	8 3
Golden Horseshoe (3s.), W.A.	4 2	3 9
Great Boulder Propriet'y (2s.), W.A.	9 9	8 6
Lake View and Star (4s.), W.A.	1 6 0	1 4 0
Sons of Gwalia (10s.), W.A.	1 15 0	1 11 3
South Kalgurli (10s.), W.A.	1 11 3	1 11 3
Waihi (5s.), N.Z.	1 1 0	1 2 0
Wiluna Gold, W.A.	2 12 3	2 10 0
INDIA:		
Champion Reef (10s.)	1 6 3	1 5 0
Mysore (10s.)	16 6	17 9
Nundydroog (10s.)	2 18 0	2 18 0
Ooregum (10s.)	8 6	7 0
AMERICA:		
Camp Bird (2s.), Colorado	8	6
Exploration (10s.)	3 6	3 6
Frontino and Bolivia, Colombia	1 14 3	1 14 3
Mexican Corporation (10s.), Mexico	9 0	8 0
New Goldfields of Venezuela (5s.)	9 0	7 9
St. John del Rey, Brazil	1 4 6	1 2 6
Santa Gertrudis, Mexico	4 9	4 6
Viborita (5s.), Colombia	4 3	4 9
MISCELLANEOUS:		
Chosen, Korea	1 2 9	1 2 3
New Guinea	5 9	5 0
COPPER:		
Bwana M'Kubwa (5s.), Rhodesia	4 6	4 6
Esperanza	6 3	6 3
Indian (2s.)	2 6	2 6
Loangwa (5s.), Rhodesia	2 3	2 0
Mason and Barry	1 0 0	17 6
Messina (5s.), Transvaal	9 6	8 9
Mount Lyell, Tasmania	18 3	17 0
Namaqua (£2), Cape Province	3 6	3 6
Rhodesia-Katanga	13 0	11 6
Rio Tinto (£5), Spain	18 15 0	18 7 6
Roan Antelope (5s.), Rhodesia	1 5 3	1 4 9
Tanganyika Concessions	15 3	14 0
Tharsis (£2), Spain	3 10 0	3 5 0

LEAD-ZINC:	Nov. 10, 1933. £ s. d.	Dec. 11, 1933. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	8 9	6 9
Broken Hill Proprietary, N.S.W.	1 10 9	1 12 0
Broken Hill, North, N.S.W.	3 10 0	3 10 0
Broken Hill, South, N.S.W.	2 11 3	2 10 0
Burma Corporation (10 rupees)	13 9	13 0
Electrolytic Zinc Pref., Tasmania	1 9 0	1 9 0
Mount Isa, Queensland	7 6	6 6
Rhodesia Broken Hill (5s.)	1 9	1 9
San Francisco (10s.), Mexico	12 0	14 0
Sulphide Corporation (15s.), N.S.W.	8 0	7 3
ditto, Pref.	14 0	12 9
Trepca (5s.), Yugoslavia	13 6	13 0
Zinc Corporation (10s.), N.S.W.	1 10 0	1 7 6
ditto, Pref.	4 10 0	4 5 0
TIN:		
Aramayo Mines (25 fr.), Bolivia	19 3	18 9
Associated Tin (5s.), Nigeria	9 3	8 9
Ayer Hitam (5s.), Malay	15 6	15 0
Bangrin, Siam	1 15 9	1 17 3
Bisichi (10s.), Nigeria	11 0	10 6
Consolidated Tin Mines of Burma	7 9	8 9
East Pool (5s.), Cornwall	1 3	1 0
Ex-Lands Nigeria (2s.)	3 0	2 9
Geevor (10s.), Cornwall	12 6	11 9
Gopeng, Malay	2 0 0	1 16 3
Hongkong (5s.), Malay	16 0	15 0
Idris (5s.), Malay	7 3	7 0
Ipoh Dredging (16s.), Malay	1 11 3	1 11 6
Kaduna Prospectors (5s.), Nigeria	8 0	8 0
Kaduna Syndicate (5s.), Nigeria	16 3	16 9
Kamunting (5s.), Malay	13 9	13 6
Kepong, Malay	15 6	15 0
Kinta (5s.), Malay	9 0	9 0
Kinta Kellas (5s.), Malay	6 9	7 6
Kramat Pulai, Malay	1 5 9	1 5 9
Kramat Tin, Malay	2 0 0	3 4 0
Lahat, Malay	7 0	7 0
Malayan Tin Dredging (5s.)	1 6 0	1 8 6
Naraguta, Nigeria	12 6	12 6
Pahang Consolidated (5s.), Malay	8 0	8 0
Penawat ($1), Malay	2 9	3 0
Pengkalen (5s.), Malay	12 3	11 9
Petaling (2s. 4d.), Malay	14 6	15 9
Rambutan, Malay	6 3	6 6
Renong Dredging, Malay	1 7 6	1 8 0
Siamese Tin (5s.), Siam	1 10 3	1 17 3
South Crofty (5s.), Cornwall	6 0	6 3
Southern Malayan (5s.)	15 0	15 0
Southern Perak, Malay	1 13 9	1 12 6
Southern Tronoh (5s.), Malay	7 9	6 9
Sungei Besi (5s.), Malay	12 6	14 0
Sungei Kinta, Malay	15 0	17 3
Tanjong (5s.), Malay	8 0	8 0
Tavoy (4s.), Burma	6 3	5 9
Tekka, Malay	13 9	13 9
Tekka Taiping, Malay	14 3	14 3
Temoh, Malay	1 1 3	1 1 9
Toyo (2s. 6d.), Japan	7 0	6 9
Tronoh (5s.), Malay	1 0 0	19 6
DIAMONDS:		
Consol. African Selection Trust (5s.)	2 3 9	2 2 6
Consolidated of S.W.A. (10s.)	4 9	4 3
De Beers Deferred (£2 10s.)	6 5 0	5 10 0
Jagersfontein	1 6 3	1 3 9
Premier Preferred (5s.)	1 18 9	1 16 3
FINANCE, ETC.:		
Anglo American Corporation (10s.)	19 0	18 0
Anglo-Continental (10s.)	5 0	5 0
Anglo-French Exploration	1 8 0	1 6 6
Anglo-Oriental (5s.)	7 6	7 3
ditto, Pref.	1 0 9	1 0 6
British South Africa (15s.)	1 1 3	1 0 3
Central Mining (£8)	18 3 9	17 17 6
Consolidated Gold Fields	3 6 6	3 4 3
Consolidated Mines Selection (10s.)	15 0	14 6
Fanti Consols (8s.)	10 9	11 3
General Mining and Finance	2 8 9	2 6 9
Gold Fields Rhodesian (10s.)	8 3	8 6
Johannesburg Consolidated	2 13 9	2 13 0
London Tin Corporation (10s.)	15 9	15 0
Minerals Separation	4 7 6	5 0 0
Mining Trust	3 9	3 3
National Mining (8s.)	1 3	1 3
Rand Mines (5s.)	6 1 3	5 15 0
Rand Selection (5s.)	16 0	16 0
Rhodesian Anglo American (10s.)	15 0	13 3
Rhodesian Selection Trust (5s.)	12 6	11 9
Rhokana Corp.	5 12 6	5 7 6
Tigon (5s.)	1 9	1 9
Union Corporation (12s. 6d.)	5 2 6	4 18 9
Venture Trust (6s. 8d.)	10 9	9 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

GOLD METALLURGY

In the *Chemical Engineering and Mining Review* of Melbourne for October 5 Dr. B. H. Moore reviews the progress in the metallurgy of gold that has taken place during the past 25 years. The author considers it necessary to consider separately the improvements and modifications in the actual methods of extracting and recovering gold from its ores and, in addition, the advances that have been made by the introduction of the more efficient machinery used in the preparation of the ores for the different methods of treatment that have come into vogue during the period mentioned. In all methods of treatment of gold ores the process naturally falls into separate sections—(1) crushing and grinding of the ore and (2) the extraction of the precious metal. As a result of diminishing gold contents of the ores with increasing depth of mining and the consequent increase in the cost of extraction of the ore the industry has been compelled to improve and modify methods of treatment so as to keep total costs down to a figure which will allow of a profit being made.

Crushing and Grinding.—In connexion with crushing and grinding practice the outstanding feature has been the general introduction and adaptation of the practice and equipment in use in the base-metal industries to the preparation of gold ores. Crushing and grinding practice has of necessity developed along two distinct lines, according as this portion of the treatment was carried out wet or dry, the former being adopted where wet methods of concentration were practised or where the treatment consisted in the extraction of the gold by aqueous solvents and the latter being adopted in those cases in which the roasting of the whole of the ore was considered necessary. Whereas, at the beginning of the period under review, gravity stamps were almost universally in use for the wet crushing of gold ores, recent installations have adopted more efficient and higher-capacity machines for obtaining the same result. Fine grinding is now common practice and, as the stamp mill is not an efficient fine-grinding machine, it is now the custom in plants in which stamps are used to employ the stamps as coarse crushers only and to delegate the work of fine grinding to tube-mills of various types. Stamps are now used to crush to $\frac{1}{2}$-in. or even $\frac{1}{4}$-in. mesh and the final grinding to minus 150 or 200 mesh is much more efficiently and economically carried out in tube-mills.

Preliminary crushing of run-of-mine ore is still performed by swinging-jaw or gyratory crushers, but for the secondary crushing of the ore, to a size suitable for tube-milling, high-capacity mills, such as the Symons cone crusher, have been successfully applied, as not only is their capacity very large but they are capable of delivering a uniform product crushed to any desired size. Tube-milling practice has been modified by the introduction of short mills of large diameter using flint pebbles, steel balls, or steel rods as the crushing medium. In almost all cases, tube-mills are now run in closed circuit with an efficient classifier, of which the Dorr or the Dorr type is probably the best known and the most used, the oversize being returned to the tube-mill and the undersize going directly to the treatment plant. This has resulted in more efficient grinding.

In dry-crushing practice very little progress has been made, ball-mills of the Krupp type being still the principal mills in use. Dry-crushing, with its attendant unhygienic working conditions, has however only been retained in cases where it would be disadvantageous to adopt wet crushing, particularly in the all-roasting method of treatment which has for many years been standard practice at Kalgoorlie, where roasting of the whole of the ore was for so long considered an essential feature of the preparation of the ore for cyanidation. At the present time the all-roasting process, which superseded all other processes at Kalgoorlie, has to compete against the revived and modified bromo-cyanide process and the flotation process, both of which have now been in operation for a sufficient period to justify the belief that they are capable of yielding as high an extraction as, but at a much lower cost than, the older dry process.

For bromo-cyanidation, which has been applied in Canada as well as at Kalgoorlie, the whole of the treatment process can be carried out wet, but the essential condition necessary to obtain a satisfactory extraction on Kalgoorlie ores is grinding to at least minus 150 mesh. In the new mill of the Boulder Perseverance this fine grinding is being carried out in one 8-ft by 6-ft. Hardinge mill in closed circuit with Dorr classifiers, the circulating load being very high. For flotation, which also has the advantage of being a wet process, fine grinding is also necessary and in the crushing section of the mill of Lake View and Star, Ltd., this is carried out in tube-mills in closed circuit with drag classifiers.

Gold Extraction.—Although the fundamental principle of gold extraction is to recover the gold at the earliest possible moment, to which end amalgamation has hitherto formed an important part of all wet treatment processes, the amalgamation method of removal of coarse free gold is now being largely superseded by the use of corduroy strakes. The object of amalgamation or of strakes concentration is not only to recover coarse gold as early as possible in a readily-realizable form, but also to prevent this gold entering the cyanide circuit where its solution would be slow and where, in consequence, the time of treatment would be prolonged, or else the coarse undissolved gold would be discarded with the residues. Blanket strakes

were used in the early days of gold milling as concentrators, whereas the modern use of corduroy strakes is not as concentrators, but simply as collectors of free gold with a minimum of other minerals. The material collected on the strakes is removed by washing down the cloths and is generally amalgamated in an amalgamating barrel to extract the free gold, the residue from the barrel, after removal of the amalgam, being returned to the mill circuit. The efficiency of this method of gold extraction is high as is shown by the fact that at Kalgoorlie 25 to 30% of the total gold content of the ore is extracted by this means, in one case before flotation, in another before bromo-cyanidation, and, in a third case, before direct cyanidation. At the Morro Velho reduction works of the St. John del Rey Co. in Brazil, where an elaborate system of strakes is in use, 60% of the gold in the ore is recovered by strakes in the form of a product containing 50% gold.

Comparative laboratory tests have shown that the extraction obtained by amalgamation and by strakes is practically the same when the gold is in a suitable condition for amalgamation, but that when the gold is tarnished or coated with some material which inhibits amalgamation corduroy strakes are more efficient than amalgamated copper plates. In those cases, where roasting of the whole of the ore is practised before cyanidation, strakes may with advantage be introduced into the circuit after the calcine has been pulped with water or cyanide solution, as was the practice in the old scheme of treatment at Lake View and Star, Ltd., prior to the change over to treatment of the whole of the ore by flotation.

The most notable mechanical advance in the treatment of gold ores has been the application during the last few years of flotation to the concentration of gold and gold-bearing sulphide minerals. During the past decade a great deal of experimental research has been conducted, principally in America and Australia, into the flotation of gold ores and it has been conclusively shown that this method of concentration can be successfully applied to the treatment of most gold ores in which the gold is associated with sulphide minerals. In most ores of this description the sulphide minerals are finely disseminated through the gangue, necessitating grinding to at least minus 150 mesh and in some cases to minus 200 mesh. Economical reduction to this degree of fineness has only been rendered possible by modern improvements in grinding machines and in classification devices. At the same time, the development and introduction of modern flotation reagents have assisted materially towards making the flotation concentration of gold ores economically feasible and successful. Western Australia can claim to possess two of the largest, if not actually the largest, gold flotation plants in the world, —namely, those of Lake View and Star, Ltd., at Kalgoorlie and Wiluna Gold Mines, Ltd., at Wiluna, both of which are now treating 40,000 tons per month by flotation alone. In both these cases, the installation of flotation plants was only decided upon after long and intensive experimental investigation of the process, both in the laboratory and in pilot plants, where it was demonstrated that the process could be successfully applied to these two very different classes of ore and that by the introduction of flotation, treatment costs could be brought materially lower than those prevailing in plants in which all-roasting was practised. In the case of the Wiluna ore, which contains both pyrite and arsenopyrite, the gold being, for the most part, associated with the latter mineral, it was conclusively proved that flotation followed by roasting of the concentrate and cyanidation of the calcine was the only method of treatment that offered any possibility of success and the conclusions arrived at, as the result of experimental research, have been fully confirmed in the flotation plant finally installed at Wiluna.

While the principles of cyanidation have undergone but little change during the period under review, many changes in practice have taken place as a result of improvements in design and construction of the machines used and by the application of the results of experimental research to the problems of cyanidation. The most important improvements in cyanidation practice have probably been in connexion with the separation of gold-bearing cyanide solution from the pulp—*i.e.*, filtration of slime and the precipitation of gold from these solutions. Prior to 1908 the separation of solution from slime was for the most part carried out in pressure filters such as the filter press, and vacuum filtration was just beginning to receive the recognition and approval of cyanide operators. The most successful filters of the vacuum type were at that time the Butters and the Moore, both of which were intermittent in action and required skilled attention. In many instances these intermittent filters have been superseded by the more efficient revolving drum filters of the Oliver type which are continuous and automatic in action. This type of filter has not only been employed for the filtration of slime but has also been successfully and extensively applied to the filtration of flotation concentrates, not only in gold flotation but also in base metal flotation.

The use of zinc dust for precipitation of gold from gold-bearing cyanide solutions has gradually extended until now there are very few large cyanide plants in which the older method of precipitation by means of zinc shavings is still in use. Precipitation by means of zinc dust has many advantages over precipitation by means of zinc shavings, among the more important of which are the lower cost for precipitant and the complete elimination of the cost of dressing the zinc boxes and the comparative simplicity of the cleaning-up operation where some form of filter, either pressure or vacuum, is used for collecting the precipitated gold slime. In connexion with precipitation on zinc, one of the most important advances of recent years has been the introduction of the Crowe process, particularly in the case of zinc dust precipitation. Whereas oxygen is essential for solution of gold by cyanide, the presence of dissolved oxygen in the gold-bearing solutions is inimical to successful precipitation and it has been found that by removing dissolved oxygen from the solutions before precipitation, the efficiency of precipitation is increased and the consumption of zinc materially decreased. In the Crowe process this de-oxygenation of the solution is very simply effected by spraying the solution into a vacuum chamber before the addition of zinc dust. This principle has been adopted in practically all large cyanide plants installed during recent years and the process of precipitation on zinc shavings has only been retained in some of the older existing plants and in comparatively small new plants.

Considerable progress has been made in the regeneration of cyanide from waste solutions and in some large plants cyanide regeneration is now in regular operation. The principle on which the regeneration processes are based is the use of sulphur dioxide for liberation of hydrocyanic acid from dilute solutions of simple alkali cyanides and alkali zinc cyanides and the conversion of the liberated acid into simple alkali or alkaline earth cyanides by neutralization. Whether cyanide regeneration is practicable in any particular case will depend on the comparative cost of new cyanide and of the regeneration of cyanide.

The factor that has had the most direct bearing on recent progress in the metallurgy of gold has been the recognition of the necessity for and the value of systematic and continuous experimental research into all phases of the processes in use and the adaptation of the results of such research and of scientific principles to practical operations. It is only by a continuance of this policy that further advances can be made.

CHLORINE SMELTING AND CHLORIDE ELECTROLYSIS

An account of progress in chlorine smelting as applied to the treatment of lead and zinc ores, together with a description of fused chloride electrolysis, is given by E. A. Ashcroft in a paper appearing in the *Bulletin* of the Institution of Mining and Metallurgy for November. The author first deals with the history of the process, from its inception in the concluding years of last century up to the carrying out of large-scale experimental work conducted at Wolverhampton between 1920 and 1926, the results of which were subsequently applied to a plant at Avonmouth capable of treating 10 tons of zinc concentrate daily. Although the work at Avonmouth carried development a stage further and again definitely established the entire feasibility of the chlorine-smelting operation and also the fractional precipitation of the other metals by zinc and the production of melts of pure zinc chloride, all in continuous large-scale operations, it yet broke down at the electrolysis of the fused zinc chloride, which is necessary to complete the economic cycle of the process. Another design of cell had been adopted differing in essential points from the cell used successfully at Wolverhampton and this proved to be a mistake and led to the abandonment of the project—for which the experiments had been undertaken under conditions involving a "time limit."

The ability to electrolyse these chlorides, after they have been obtained in a state of anhydrous purity, at a maximum expenditure of energy of about 2 k.w.-hrs. per lb. of zinc, or of 0·66 k.w.-hrs. per lb. of lead, by the use of single-couple cells, should, the author states, have never been in doubt since the Swinburne-Ashcroft experiments which were commenced in 1899 and concluded in 1903. The conclusions drawn from those experiments, though little noticed at the time, found confirmation unexpectedly in 1929 by the revelation of Sir Richard Threlfall's important work, which was carried out between the years 1907 and 1915, but was kept secret until June, 1929. That work is remarkably similar to the Swinburne-Ashcroft earlier work and to the Ashcroft-Lacell later.

The designs and execution of the Avonmouth plant were brilliantly carried out for the operating company by Lacell, whose consistent belief in and advocacy of the chlorine-smelting system did much to help it forward during the several years he was connected with it. Unfortunately, however, a serious departure was made from the design of electrolytic cell already tried out successfully and, although about 100 tons of high-grade zinc were actually produced, yet in the final result Lacell's cells were not successful, the reason assigned being excessive consumption of the graphite plate electrodes and disintegration of the cells. And so the matter was left at the conclusion of the trials in 1926–7. The whole matter narrowed down at the conclusion of the latest trials to a single point—the design of a suitable apparatus in which to electrolyse the fused zinc chloride at a moderate consumption of energy and in which the electrodes, etc., would be reasonably permanent. The author believes that he is in possession of the key to this problem and is satisfied that cells can be designed to-day which will stand up to the necessary conditions and produce the zinc at a total expenditure of electrical energy of less than 1 k.w.-hr. per lb. of zinc and about 250 watt-hours per lb. of lead. It may be noted here that the average requirement by the modern wet electrolytic sulphate process is over 1·5 k.w.-hr. per lb. of zinc.

A description of the conversion operation, which has proved successful from the first trial onwards, is given earlier in the paper. The chlorine reaction is carried out by suspending the ore in a mobile melt of the mixed fused chlorides of the metals and bubbling chlorine through the suspension, which is fed with ore and thus continuously and automatically augmented and maintained at the requisite temperature (which was shown to be 600° C.) by the reactions and by regulating the flow of chlorine. The apparatus resembles a large thin-walled bessemer converter. This was the first, and is apparently the only practical method of carrying out Swinburne's reaction.

The author then goes on to a technical description of the improved process and says that there are three principal normal ways of working it after the converter and various possible modifications of each. Selection will always have to be made according to the composition of material treated and general economic circumstances and flow sheets must be laid out accordingly. The first flow sheet (one used at Wolverhampton and at Avonmouth) is called the dry cycle and consists in precipitating iron and lead together from the fused melt, as metals by zinc, settling the heavy alloys—or mixed metal precipitate—and gangue and pouring off the clear chloride and washing out only the adhering chloride. The second flow sheet, in which the melt is all lixiviated in water after leaving the converter, is called the wet cycle. There is a third cycle of more recent origin which must be noticed because it promises to be especially useful in the treatment of zinc ores whose gangues are high in iron sulphide—an extensive Canadian type. That cycle makes use of the principle of partial chlorination in the converter followed by immediate distillation of the chlorides in chromium steel retorts at 850°–900° C. It is called the distillation cycle. It has so far only been developed on a large laboratory scale, but satisfactory results of large-

scale work of a closely-allied character are available in connexion with a recent tin process development.

The principal reactions which take place with various minerals fed to the converter are so well known that they need not be mentioned here. It may be remarked that at 600° C. the sulphides, sulphates, and/or the more reactive of the oxides and/or silicates of practically all the metals are converted to chlorides quantitatively. The less reactive oxides, such as cassiterite and some forms of iron oxide, zinc ferrates, franklinite, chromium oxides, and wolfram, are only attacked in the presence of a reducing agent such as suspended charcoal or at higher temperatures. There is no doubt that the most active reagent in attacking the sulphides is ferric chloride and as this is reduced to ferrous chloride by the reactions with sulphides and again brought to the ferric state by taking up chlorine from the chlorine blast the iron chloride really acts as a catalyst and a relatively very small amount of it only need be present to effect the rapid chlorination of a charge of the most refractory sulphides. As little as 1% Fe in a melt is fully effective. With oxides the case is different, as the reaction of ferric chloride with zinc or lead—or most other—oxides throws the iron out as ferric oxide and the latter is only very slowly re-attacked by chlorine and only at all when no more zinc oxide-bearing material is present. It is for this reason that whenever iron is high in an ore or concentrate crude zinc oxide may be introduced—at the latter part of the chlorination—to remove it and to substitute zinc chloride, the melt being afterwards settled and poured off, lixiviated, or distilled as elsewhere explained. The sulphur is all eliminated and distils over as elemental sulphur—unless there be also present oxygen with the chlorine, or as oxides with the sulphides, in which case the corresponding proportion of sulphur is burned, usually quantitatively according to the amount of oxygen present, and passes off as sulphur dioxide. Chlorine gas, with a strength of at least 80% to 90% Cl_2 by volume, is easily obtained from the cells (especially from multiple couple cells) and the admixture of 20% by volume of air corresponds to the burning of only about 3%—or less—of the total sulphur and is of no great importance, whilst the freed nitrogen from such air in small amounts is distinctly beneficial in that it stirs and well mixes the contents of the converter.

Separation of iron and lead, with silver and small amounts of gangue (dry way). The melts, as tapped from the converters, may be depended upon to be completely neutral and would be in an ideal state for electrolysis were it not for the inevitable presence of small amounts of iron chloride and a little siliceous gangue matter—the latter however, being easy to eliminate by settling upwards and/or downwards. Lead as chloride—in admixture with zinc chloride—may be completely and easily removed and recovered by zinc—at quite low temperatures—and also by electrolysis. In the one case zinc chloride and in the other free chlorine are also produced. But iron has the unfortunate property of coming down before and towards the end largely with the lead, so that the lead is bound to be contaminated if iron is present, and much the same is the case with copper, nickel, and cobalt.

The melt—as tapped from the converter and now containing, say, 0·5% to 10% each of lead and iron and a few per cent. of solid suspended gangue—is received into a round-bottomed cast-iron (or steel) vessel—covered and provided with a propeller agitator—where it may be allowed to cool to about 450–500° C. For experimental purposes this vessel may be provided with gas heating, but in regular work the heat of the reactions is sufficient. Coarse zinc powder is introduced and stirred well in in molecular quantity for all the iron, lead, silver, etc., present and results in the immediate formation of a heavy alloy (or mixture) of these metals in granular form with all gangue or other solid matter entrapped, which quickly settles to the bottom of the melt on stopping the agitator. Copper, nickel, cobalt, and cadmium are all also precipitated and many other impurities if present, leaving the zinc chloride neutral-pure and water-white; a liquid quite (or very nearly) suitable for the cells if all has been carried out correctly. It is imperative, however, not to expose this melt to air or moisture at all, or to place it in a position to take up any basic matter, because it avidly absorbs both oxygen and water in small amounts, especially at temperatures above 300° C., although actual fuming is not very noticeable until the temperature reaches 350° C. and upwards. At higher temperatures fuming is great and the melt becomes rapidly basic if exposed. The melt when it becomes basic will take up small amounts of silica from brickwork, etc., and when slightly moist it will take up small amounts of iron from iron vessels, all of which things are injurious for the electrolysis as hereafter noted and prevention in such cases is better than cure. Therefore, care and understanding in the treatment of the melt before it goes to electrolysis are vital points in this process at all times.

The zinc for the precipitator is prepared in the well-known way by blowing a stream of molten zinc, at a temperature only just above its melting point, with cold air. Ordinary zinc dust should not be used. After the converter has discharged its finished contents into one of these vessels the agitator is started and the whole charge is kept in somewhat violent motion in the covered vessel. The zinc is now added slowly in correct amount to substitute the iron and lead. At first the iron is thrown out until about 1·8% only is left in the melt, whilst there may be left 6% or more of lead. After that they come down together until only zinc chloride and perhaps 0·1% each of lead and iron remain.

Iron may be removed by other methods, or the melt may be treated by the wet process, until finally a pure zinc or lead chloride melt is obtained which can be electrolysed in specially-designed cells of a multiple-couple type, the whole process being cyclic in its operation.

After dealing exhaustively with the design of suitable multiple-couple cells the author discusses the economics of the process and concludes with suggestions for procedure in its final development. He says that the last stage in all such processes is apt to be the most expensive, because it is so seldom realized that experiment, properly so called, if conducted on too large a scale, is inherently very costly and time-consuming and there is no means of making it otherwise.

Cells on the multiple system, although far advanced towards perfection, still require a little further development and such development will involve prolonged running of single units. To make such final development as inexpensive as possible the quickest and cheapest way both for running

the single-unit multiple-couple cells (which should be tried out for fairly long periods) and for procuring supplies of pure fused zinc and lead chloride for them and for disposing of the chlorine by-product must be selected; and it is upon the nature of such selections that the chief cost of the work yet remaining to be done will mainly depend. Taking all things into consideration the most favourable location for a small development plant would seem to be in close association with one of the—already installed—electrolytic alkali plants, under arrangements whereby intermittent supplies of cheap chlorine and cheap electricity may be obtained, and the produced chlorine may be re-sold or used experimentally as occasion may dictate, whilst all other usual works facilities would be available for general purposes at moderate cost. Failing that, a quite small alkali plant might be erected and alkali and some chlorine sold systematically, leaving chlorine to be drawn on as required. It is the intermittent running of and experimental alterations to small non-commercial plants (with the attendant lapse of time and accumulation of over-heads), when on anything larger than a full-sized laboratory scale, that causes the considerable cost which is well known frequently to attend such work.

The author considers that there is now justification for a semi-commercial installation of the chlorine-smelting process and the best way to approach it is to treat first lead concentrates and then zinc concentrates, using first single-couple cells—on the principles above discussed and well demonstrated by Threlfall—and then, when multiple-couple units have been fully developed, passing on to multiple-couple cells for zinc electrolysis and to such further developments as may be suggested by experience.

CYANIDATION AT McINTYRE PORCUPINE

In an account of activities at McIntyre Porcupine Mines that appears in the *Engineering and Mining Journal* for November there is a section devoted to cyanidation practice. Approximately 230 tons of concentrates from the flotation section are treated daily and these flow from the dewatering filters to the drum feeder of a No. 6 Allis-Chalmers 5 by 16-ft. tube-mill, which is in closed circuit with a 6 by 30-ft. duplex Dorr classifier. The mill is driven at 29 r.p.m. by a 150-h.p., 550-volt, 375-r.p.m., slip-ring motor through a 13·0 : 1 double helical gear and pinion. It is loaded with 30,000 lb. of 2-in. forged steel balls, 800 lb. being added daily. Moisture content of the pulp is maintained at 40%. Rubber liners, 1 in. thick and having a life of approximately two years, are attached to the mill shell by manganese-steel retaining bars spaced 15 in. c. to c. End liners are of white iron, 3 in. thick, and are replaced every sixteen months.

The classifier is operated at a slope of $2\frac{1}{2}$ in. to the ft. and is driven by a 5-h.p. motor through a V-belt and a Reeves variable-speed drive giving a range of 10 to 20 strokes per minute on the rakes. The overflow product at 7 : 1 dilution shows 92% minus 200 mesh and 80% minus 325 and passes to a pump box, where it joins the overflow from No. 7 classifier at 1 : 1 dilution, thus making an average dilution of 3 : 1 in the agitators. The pulp is then pumped by a 6-in. Morris sand-pump to the first of six agitators, which are in series. The pump is driven at 810 r.p.m. by a 50-h.p. motor through a V-belt, against a discharge head of 23 ft. For aëration purposes a portion of the pulp is drawn from the bottom of No. 1 agitator by a bypass arrangement and joins the current flow.

The six Dorr agitators, 24 ft. in diameter by 20 ft. deep, are driven at 13 r.p.m. by individual 5-h.p. motors through 4·22 : 1 Falk reducers and belt drives. Each is equipped with a 36-in. discharge cone and a 6-in. air lift which circulates the pulp back to the tank or sends it forward to the next agitator if so desired. Each tank is connected to the one following by 6-in. pipes, located 3 ft. from the top, as well as welded steel launders stepped down from tank to tank to take care of current froth. The pulp is passed from the final agitator to a Dorr bowl classifier by a 6-in. Morris sand-pump, driven at 920 r.p.m. by a 50-h.p. motor through a V-belt, against a 53-ft. head.

The bowl classifier is 20 ft. in diameter with a reciprocating rake compartment, 6 by 30 ft. long, having a slope of 2 in. to 1 ft. and raking at seven strokes per minute. The bowl section, which slopes at 2 in. to 1 ft., has a rake speed of $1\frac{3}{8}$ r.p.m. The classifier is driven by a 10-h.p. squirrel-cage motor (mounted on the tank compartment) through a V-belt drive to a line shaft which in turn operates both the reciprocating and bowl rakes through belt drives.

The reciprocating rakes will not handle the return product under the conditions necessary to obtain the desired fineness in the overflow; therefore the bowl is operated on the principle of a settling cone, the underflow discharged by gravity through a spigot at the bottom of the tank to the feed end of No. 7 regrinding tube-mill with a moisture content of 40%. The bowl overflow travels to the thickener through launders at a dilution of 8–10 to 1, giving a product of 98% minus 325 mesh.

Underflow from the bowl classifier is ground in No. 7 tube-mill operating in closed circuit with a duplex classifier. In mechanical details the mill and classifier are identical with No. 6 except that $1\frac{1}{4}$-in. balls are used, added at the rate of 800 lb. daily. Classifier overflow from this unit is kept at 1 : 1 dilution and joins the flow from No. 6. Bowl overflow is split to four points on the periphery of a 50-ft. Dorr tray thickener, 14 ft. deep, driven by a 5-h.p. motor, at one revolution in 5 min. through a 6·93 : 1 Falk reducer and belt drive.

Froth is taken care of in the tray compartment, also a large percentage of the solids, and the partially clarified solution flows down the centre well to the bottom section, from which all the solution is drawn, at two points on opposite sides of the thickener. Pulp is removed at 50% moisture by two 4-in. Dorr duplex diaphragm pumps, two of which are driven from a line shaft through a belt and a Reeves variable drive. The other two are driven by a direct belt drive from the same line shaft. The suction of one pump is submerged in the froth on top of the thickener while two others pump the pulp from the bottom of the tray, the

remaining one being used to take care of the pulp from the bottom of the tank.

Thickened pulp flows from the diaphragm pumps to a surge tank, 6 ft. in diameter by 12 ft. deep, from which it is sent to the first stage filters by a 4-in. Wilfley pump, driven at 890 r.p.m. by a 15-h.p. motor, through a V-belt. Overflow from these filters returns to the tank.

Three stages of filtering are required for elimination of pregnant solution from the cake. For this purpose there are five American filters—two on both first and second stages and one on the third stage. Each machine has eight 8-ft. 6-in. disks with drives like those used for dewatering concentrate. Every shift two rows of bags are removed from one filter in each stage and acid-treated. This completes the cycle in eight days.

From the first stage the cake, after being sprayed with barren solution, is discharged at 20% moisture to re-pulpers like those used on the dewatering filters. The pulp is diluted with barren solution to 1 : 1 and goes to a 12 by 14-ft. steel surge tank equipped with Dorr agitator mechanism and driven from a line shaft at 10 r.p.m. It is then pumped against a 25 ft. head to the second stage by a 4-in. Wilfley similar to that used on the first stage. Second- and third-stage filtering is identical with the first except that one machine is used on the final stage. Periods occur when carbonaceous material is present in the ore and is passed to the cyanide circuit. This is indicated by the abnormal assay of froth on the agitators and thickener, resulting in an increase in the residue value. This condition is overcome by diverting the washed residue to two six-cell Denver Sub-A flotation units before discharging it to waste. Due to the effect of the cyanide in the prior treatment approximately 95% of the material is depressed and the values are recovered in the form of a concentrate and returned to the cyanide circuit for further dissolution.

The filtrate from the first-stage filters is drawn into a 3 by 8-ft. steel receiver from which it is pumped to the thickener against a 20-ft. head by a 4-in. Rees Roturbo (similar to that used on the dewatering filtrate) showing a vacuum of 26 in. at the intake. The combined filtrate from the second and third stages is drawn into a duplicate receiver from which it is sent to a 4½ by 10-ft. steel storage tank by a 6-in. Rees Roturbo pump operating against an 8-ft. head and showing 26 in. of vacuum on the suction line. This is driven at 1,500 r.p.m. through V-belts by a 25-h.p. motor. From the tank the filtrate and excess thickener solution is pumped to the mill cyanide storage tank by a 7 by 9-in. Aldrich triplex pump. The storage tank is of the same size and situated at the same elevation as that receiving the dewatering filtrate. The Aldrich pump is operated against a 69-ft. head by a 20-h.p. motor through a V-belt drive and 5:1 gear and opinion at 76 strokes per minute.

Pregnant solution from the thickener goes to a 15 by 26-ft. steel tank; from here a 7 by 9-in. Aldrich triplex pump sends it to two clarifying presses, 42 by 42 in. with 25 frames each, using 10-oz. canvas. The sluicing mechanism is driven from a line shaft through a worm gear and belt at 3 r.p.m. Canvases are cleaned and acid-treated approximately every five days and have a life of three weeks.

Clarified solution flows to a 15 by 26-ft. steel storage tank from which it is pumped by a 4-in. Rees Roturbo, direct-coupled to a 15-h.p. 1,500-r.p.m. motor, to the top of a 5 by 12-ft. Crowe vacuum receiver situated 44 ft. above the bottom of the pregnant storage tank. Between this tank and the Crowe receiver a 5 by 3¾-in. Venturi tube measures and records the solution tonnage precipitated.

In the Crowe system a Rix-Gardener dry vacuum pump is used and operates from the line shaft which drives the sluicing mechanism on the clarifying filters. The shaft is driven by a 10-h.p. motor through a belt drive. A 7 by 9-in. Aldrich triplex pump sends the solution, to which lead acetate is added, from the Crowe tank to the precipitation presses. Zinc dust is fed by a Merrill feeder to the intake of the pump through a 2-ft. 4-in. (diameter) by 2-ft. 8-in. cone. Strong cyanide solution is also added at this point to aid precipitation.

Precipitation is effected at the rate of 1,600 tons per day in three 52-in. triangular Merrill presses each with 22 frames. Two presses are used continuously, the third acting as a spare. Twelve-ounce canvas and unbleached sheeting are used. At intervals the canvases are acid-treated. They last about three months. The sheeting is burned and mixed with the precipitate at each clean-up. Every ten days the presses are cleaned, the resultant precipitate being transferred to an acid-treating tank in the refinery through a 10-in. pipe in the press-room floor.

From the presses the barren solution flows to a 12 by 14-ft. steel storage tank from which it is pumped, by a 7 by 9-in. Aldrich, to the filter spray system and to supply gland solution on pumps. Surplus solution goes to the mill cyanide storage tank. A pressure valve arrangement on the pump-discharge line maintains a pressure of 50 lb. per square inch on the filter sprays and glands.

Vacuum for filtration is maintained at 28 in. by three 23 by 12-in. Ingersoll-Rand vacuum pumps having a capacity of 2,188 cu. ft. per min. each; two are in continuous service and one is a spare. They are driven by 100-h.p. motors through short belt drives equipped with idlers and operated at 190 r.p.m.

Air required for agitator air lifts and filtration is supplied at 20-lb. pressure by a 2,000-cu. ft. Size 11, Type 23A, Sentinel Alley and McClellan air compressor. This is driven at 290 r.p.m. through a V-belt drive by a 200-h.p. motor and is equipped with the usual lubricating system, intake air filter, and receiver. One spare Sullivan air compressor of 1,000-cu. ft. capacity is available. This is driven at 142 r.p.m. through a flat belt drive by a 125-h.p. motor.

Cassel sodium cyanide is used and is added at Nos. 6 and 7 tube-mills and agitation tanks as well as at the zinc cone. The lime used has a solubility of approximately 85%; it is slaked and added periodically to the tube-mill feed by the operators. Cyanide and lime strength in the solutions are maintained at 3·5 lb. and 0·75 lb. respectively.

Tailings Disposal (Entire Mill).—All mill tailings are disposed of at 33% solids, through an 8-in. wood-stave, self-draining line, against a head of 20 ft. The line discharges at a point 1,000 ft. north of the mill, where the elevation permits of gravity flow to a natural tailings pond, protected at low points by sand and gravel embankments built to a height of 20 ft. The area of the pond is 125 acres with a storage capacity of approximately three million tons. The solution overflow is controlled by weirs located at a central point of the lower dam and flows to Porcupine Lake 5 miles away.

SWAYZE GOLD AREA, ONTARIO

In December, 1932, an account of preliminary work in the Swayze township gold area, Sudbury district, Ontario, by H. C. Rickaby, was reproduced in these columns and a similar account, covering work done in the area during 1933, has now been issued by the Provincial Department of Mines. Mr. Rickaby says that the geological work done the past season in the Swayze gold area consisted largely of a detailed examination. The area includes the townships of Halcrow, Denyes, Swayze, Raney, and Rollo, the west half of Dore township, and the north parts of the townships of Tooms, Greenlaw, and Cunningham.

General Geology.—The Swayze area is underlain by Keewatin greenstones consisting of basic to acid lava flows, tuffs, etc. The greenstones are traversed from east to west by two bands of rocks essentially sedimentary in origin, and known hitherto as the Ridout series and the Swayze series. The main point of interest from the geological standpoint, as shown by the recent work, is the fact that the two series are apparently equivalent in age and that they overlie the Keewatin greenstones. Between the Ridout series and the Swayze series is a band of greenstones forming an anticlinal fold. In the north-west part of Halcrow township this fold plunges steeply to the west as shown by the fact that sedimentary rocks corresponding to the north side of the Ridout series were followed almost continuously around the nose of the anticline to where they joined similar sediments forming the south side of the Swayze series. It was previously established that the Swayze series is synclinal in structure and it seems quite probable that the Ridout series is also in the form of a closely folded syncline. The axis of the Swayze syncline strikes approximately east and west while that of the Ridout series strikes somewhat south of east. The axes of both synclines dip steeply to the north. Besides these two main structural features there are a number of smaller bands of sediments which probably represent infolded remnants of the same age as the Ridout and Swayze series. All these structures tend to emphasize the magnitude of the folding which characterizes the basement rocks of the Swayze area.

Timiskaming Series.—The preceding paragraph implies that the various bands of sediments in the Swayze area lie stratigraphically above the greenstones. Evidence as to the magnitude of the discordance separating the greenstones and sediments is somewhat conflicting, possibly due in part to the high degree of schisting and faulting along the contacts. Good conglomerates containing granite pebbles were noted along the north and south sides of the Ridout series and along the south side of the Swayze series. At other points the contact seemed to be a gradational one passing upward from flows through tuffs to well-bedded greywacke or other sediments. However, the general stratigraphic relationship of the sediments to the underlying greenstones appears to suggest the probability that the former are Timiskaming in age.

Algoman Intrusives.—A second point of interest brought out by the past season's work is the nature and amount of intrusives of Algoman age which occur in the greenstones and sediments. These intrusives consist of granite, granodiorite, diorite, quartz and felspar porphyry, and lamprophyre. A series of parallel dykes of quartz and felspar porphyry occurs in a band extending from the north-west part of Halcrow township eastward across the north parts of the townships of Halcrow, Denyes, Swayze, and Dore. These dykes show widths from a few feet up to 1,000 ft. or more, striking approximately east and west. This band of porphyry lies for the most part within the belt of sediments known as the Swayze series, but other dykes of porphyry, granodiorite, etc., are of widespread occurrence in the greenstones and sediments throughout the area. A number of small bosses of granite and granodiorite were noted in the townships of Rollo, Raney, Halcrow, and Tooms.

Prospecting Activity.—During the past season prospecting has been fairly active in the area and a number of new discoveries of gold-bearing veins have been made tending to extend considerably the area of rocks favourable for gold deposition. In the following a few notes will be given on developments at some of the prospects in a more advanced stage and on a few of the newer discoveries.

Kenty Gold Mines, Ltd.—The general geology of the Kenty property has been described previously. It consists essentially of an east–west belt of Keewatin andesitic lavas forming an anticlinal fold with sediments on both limbs of the fold. The sediments to the south are intruded by wide dyke-like bodies of porphyry and smaller dykes of porphyry and lamprophyre intrude the greenstones. The veins belong to the lode type or deposits consisting of a series of parallel veins or vein-systems occurring in the greenstones, sediments, and intrusives over a distance of approximately 3,600 ft. in an east–west direction. Two shafts approximately 1,800 ft. apart have been sunk to a depth of 500 ft. and 1,100 ft. of lateral work, including 450 ft. of driving, has been done up to date. The underground work so far is entirely in line with what might be expected in view of the promising nature of the surface indications. There appears to be no significant change in conditions as seen on the surface down to and including the 500-ft. level and no information has as yet been obtained below the level. Near No. 1 shaft the contact between the greenstones on the north and the sediments on the south stands almost perpendicularly. The veins on the surface lie mostly well within the greenstones, but dip toward the sediments. No. 1 vein passes at depth from the greenstones into the sediments, but without any marked change in appearance. This vein is, however, nearer the contact than most of the other veins exposed on the surface. Underground work in the next few months will probably afford some important information on the Kenty veins. The plant, now in use, capable of operating three machines underground along with the hoisting and other equipment, is being continued temporarily.

Halcrow-Swayze Mines.—This property lies near the centre of Halcrow township. The showings consist of a mineralized shear zone in an impure quartzite of the Ridout series, striking S. 60° E. and dipping about 80° to the north-east. The shear zone has been traced for approximately 2,000 ft. in length, of which 1,000 ft. is reported to show moderate values in gold over widths up to 7 or 8 ft. The mineralization consists of pyrite, chalcopyrite, and carbonates. The south wall is a fault with quartzite in contact with greenstone tuffs on the

south side. The values on the main shear zone are reported to be low, but a number of cross fractures with quartz carrying considerable pyrite and chalcopyrite are reported to show good values over narrow widths. One of these fractures uncovered this summer about 800 ft. east of the shaft shows good mineralization over a length of 200 ft. and is reported to show values of $10 to $14 across 3 to 4-ft. widths. A shaft has been sunk in the main shear zone to a depth of 200 ft. and driving to the east and west is being carried on.

Derraugh Property.—This property lies near the east boundary of Denyes township near the 4-mile post. The country rock consists of greywacke and quartzite of the Swayze series cut by numerous dykes of quartz porphyry. The discovery vein is on claim S-22459, about 10 chains south of the No. 1 post and 300 ft. from the east boundary. It consists of quartz lenses and stringers along a fault striking north and south and dipping steeply to the east. The quartz stringers and lenses occur over widths up to 10 ft. and are mineralized with carbonates, pyrite, chalcopyrite, and a little galena. The vein has been stripped for a length of approximately 300 ft. No visible gold was noted but surface sampling is reported to have shown good values over mining widths in some sections. Thirteen hundred feet west of No. 1 vein, near the west boundary of the same claim, another vein (No. 2) shows a rusty silicified arkose with small quartz stringers occurring over a width of 25 ft. This zone was traced for 75 ft. in length striking N. 20° E. It is mineralized chiefly with pyrite and carbonates and was reported to show low values in gold. This property was under option to the Kirkland Hudson Bay Mines, Ltd., who did some diamond drilling during the winter of 1932–3. Thirteen shallow holes were put down, eleven on No. 1 vein and two on No. 2. The Company abandoned their option and no further prospecting was done till late in the present summer. Recently another vein has been discovered lying near the boundary line between Claims S-22458 and 22461, about 400 ft. north of the south boundary. The vein is somewhat similar to No. 2 vein of which it may be the extension. It has been stripped for over 400 ft. striking north and south and shows an average width of 7 ft. or so. It contains stringers and lenses of quartz mineralized with pyrite, chalcopyrite, and some galena. No gold is visible, but pannings indicate fair values. A small crew of men are engaged in stripping and trenching.

Sylvanite Gold Mines, Ltd.—During the past summer a crew of six men has been prospecting the Sylvanite group of claims, which lies in the western part of Denyes township. In the south-east corner of Claim S-21131, trenching has uncovered a series of parallel porphyry dykes striking S. 66° E. intruding schistose sediments and tuffs. The porphyry and schist have been fractured and the fractures filled with quartz heavily mineralized with pyrite and carbonates. One main leader of quartz has been stripped showing a length of approximately 200 ft. with widths up to 3 ft. No gold is visible, but channel samples taken over 3-ft. widths over a length of 160 ft. of this vein are reported to show values up to $8 per ton in gold. Trenching and stripping operations are still being carried on and the management is reported to be contemplating some diamond drilling this coming winter.

Lee Gold Mines, Ltd.—This property comprises a group of 17 claims lying in the north-west part of Greenlaw township. Near the centre of Claim S-23938 a discovery of gold was made early in the present year. The deposit consists of a shear zone in a diorite near the north side of the Ridout series. The diorite is cut by a dyke of quartz porphyry from 10 to 25 ft. wide striking S. 55° E. and traced for a length of 600 ft. Along the walls of the porphyry the diorite has been silicified and replaced by carbonates and pyrite. Narrow stringers of quartz carrying considerable chalcopyrite occur in the schist and this material shows appreciable values in gold. The mineralization is most marked in the porphyry and the schist immediately adjacent to it. A number of trenches and test pits have been sunk where the ground is favourable, showing a length of approximately 300 ft. of mineralized schist. Diamond drilling has been in progress for the last two months but results are not yet available.

Mallard Township.—Three discoveries of gold have been made in Mallard township, which lies 12 miles east and slightly south of Swayze township.

Woman River Syndicate.—The property of the Woman River Syndicate of New Liskeard lies in the north-west part of Mallard township on the Woman River. The showing occurs on Claim S-20506 at a falls on the river. It consists of narrow quartz veins and stringers in andesite which is intruded by narrow dykes of porphyry. The largest of the quartz veins showed widths up to 3 ft. and had been stripped for a length of 20 ft. The quartz is heavily mineralized with pyrite. No gold was visible. A channel sample across 3½ ft. was reported to have assayed $5 per ton in gold. A grab sample from this vein assayed $6·80 per ton in gold. Across the river, approximately 400 ft. west, a trench shows similar conditions—*viz.*, a narrow porphyry dyke cutting schisted greenstone with some quartz and pyrite.

Mogridge Claims.—This property lies in the centre of Mallard township, on the Opeepeesway River. The discovery lying near the N.E. corner of Claim S-24798 occurs in an area of schisted greenstone and tuffs. The strike of the schist is S. 45° E. and the dip vertical. The gold occurs in a silicified and carbonated zone in the schist, the zone being parallel to the strike of the schistosity. Very little vein quartz is present. The schist is heavily mineralized with pyrite with a little chalcopyrite. The mineralized zone has been traced for a length of 500 ft., showing widths up to 30 ft. Five hundred feet of drilling in four short holes was done over a length of 520 ft. Grab samples of the pyritized schist from the surface showed values up to $9 per ton in gold.

Hermiston Claims.—Half a mile east of the Mogridge discovery a somewhat similar showing occurs. Near the east side of Claim S-24851 a mineralized zone is exposed in two trenches 80 ft. apart. The strike of the schist is S. 45° E. The mineralization occurs over a width of 15 ft., showing lenses of quartz with considerable pyrite. In the south-east trench a dyke of felsite, 10 ft. wide, cuts the greenstone parallel to the schistosity. Two grab samples of the pyritized schist from this find assayed $4·20 and $5·60 per ton in gold.

Horwood Lake.—Several new finds have recently been reported from the area north of the township of Newton and Dale and west of Horwood Lake. A visit was paid to the claims of the Eclipse Airways at the end of the season. The group of claims lies on the Swayze River immediately north of

the north boundary of Newton township. The country rock consists of greenstone with some coarse dioritic phases cut by porphyry dykes. A number of fractured zones containing narrow quartz veins and stringers have been exposed by trenching on these adjoining claims. The veins are mostly either flat lying or dip at low angles and are mineralized with pyrite and a little chalcopyrite. One vein from 6 to 8 in. wide and exposed for 30 ft. in length showed some native gold and a number of these small veins are reported to show gold in panning.

Conclusions.—The past season's work in Swayze, although failing as yet to prove up large deposits of commercial grade, gives considerable encouragement in that conditions favourable for gold deposition exist over a wide area. The country is rather difficult to prospect since the overburden is fairly heavy. Geological conditions both from a lithological and structural point of view are decidedly favourable and the field will undoubtedly afford scope for intelligently directed prospecting effort for some years to come.

CLEANING UP A SMALL CYANIDE PLANT

In a pamphlet entitled "Hints to Prospectors and Owners of Treatment Plants" issued by the Royal Mint, Perth, Western Australia, a section is devoted to the clean-up of a small cyanide plant. These directions read: Stop the flow of solution through the extractor box and siphon most of the solution out of each compartment. Then start to clean out the top compartment. Any long zinc useful for further precipitation should be well washed in a tub of clean water to remove any loose gold and should be set aside for re-use. All sludge (gold and fine zinc) in the first compartment should be transferred to a wooden cask or other suitable vessel, the compartment being thoroughly cleaned. Most of the gold will be found in the first compartment if the box has been properly attended to from day to day. Then proceed with the second and subsequent compartments, washing all long zinc thoroughly and replace it in the first compartment until it is filled. Each compartment in its turn should be well cleaned and all sludge should be transferred to the cask. When all compartments have been cleaned out and the long zinc placed back in the box, new zinc is added as required to the lower compartments. When this is done the solutions can then be allowed to flow through the extractor box again.

The contents of the tub in which zinc has been washed are then transferred to the cask, which should be filled with clean water, well stirred, and allowed to settle. When much copper is present in the sludge a roast may be given here, before the sulphuric acid treatment. The advantages are: (1) the copper oxidizes and is readily dissolved in the sulphuric, (2) the zinc is oxidized and, as zinc oxide dissolves in the acid more quietly, (3) avoidance of fumes from decomposition of cyanogen compound, (4) eliminating the use of nitric. In the hands of a careful operator roasting gold sludge can be effected without any loss of consequence. The sludge should not be stirred when it is becoming dry, or gold will be lost by dusting. The method of making and using a roasting pan is given later. Take a second cask or suitable vessel and pour into it several gallons of warm water. Pour into the water as much strong sulphuric acid as will make a 10% solution. Half a kerosene tin of water to half a Winchester quart of sulphuric acid is about the right proportion. Be very careful to pour the acid slowly and steadily to prevent splashing, as it can inflict a nasty burn.

When the contents of the No. 1 cask have settled siphon off and collect the clear liquor in a suitable tank or vessel for subsequent treatment. The sludge should then be added to the acid in handfuls at a time, stirring with a stick continuously. This should be done in the open air, in order that the fumes will blow away and do no harm. Do not add too much sludge to the acid at one time. It usually takes a couple of hours at least to complete aciding, but will take much longer if too much sludge is added or if acid is poured on to the sludge instead of as described. Keep stirring right through the process. If much copper is present in the sludge, and the roast treatment described above has not been given, add sufficient but small quantities of nitric acid, which will dissolve the copper. When the sulphuric acid has done its work, fill the cask with water, warm if available, stir well and allow to settle properly. Then siphon the clean liquor from the cask and collect it in the tank before mentioned. Fill the cask with clean fresh water, stir thoroughly, and allow to settle again. The second settling will be quicker than the first and may take only half an hour or so, whilst the first settling may require an hour. Siphon off the clear liquor and send it to the tank.

Now transfer the washed sludge to a filter made of double unbleached calico sewn to a hoop and in the form of an inverted cone or bag. When it has drained, gently pour on to it a gallon or two of boiling water and allow to drain. Then cut the calico from the hoop and transfer the lot to a roasting pan. A roasting pan may be made from a sheet of black iron with the edges turned up, say, 4 to 5 in., the corners crimped, not cut. A convenient size is 5 by 2 ft. To prevent buckling, place the pan on a sheet of fairly heavy iron or steel to keep the heat of roasting from direct contact. To it add a small amount of nitre (dissolved in hot water), not more than 2½% of the weight of sludge. Apply heat gradually, stirring well while the sludge is moist. The sludge will become rubbly before dry, but do not stir when it becomes dry, because gold will be lost by dusting. Bring to a red heat, but do not fuse. The calico will be burnt and be reduced to ash. Keep at a dull red heat for half an hour, then allow to cool.

To roasted sludge add 50% by weight of borax glass and melt. If the sludge is not as clean as it should be, add with the borax glass a little bicarbonate of soda and sand. The liquors siphoned off during the clean-up should be allowed to settle for a week, when the clear liquor should be run to waste and the residue in the tank should be cleaned out, dried, and melted. The extractor box should be attended to daily or as often as necessary. Do not add new shavings to the top compartment, but move up shavings from the second compartment and so on. All new shavings should be added to the bottom compartments.

MILLING AT BRALORNE MINES, BRITISH COLUMBIA

A description of the Bralorne mill of the Bralorne Mines company is given by F. E. Gray in the *Canadian Mining and Metallurgical Bulletin* for November. The mill is situated on the government highway in the Bridge River mining district of British Columbia, approximatly 50 miles north-east of Shalalth, the shipping point on the P.G.E. railway. Prior to 1931 the property now owned by Bralorne Mines, Ltd., was operated by Lorne Gold Mines, Ltd. During the early operation of the mine the ore had been treated at various times in one of three small amalgamation mills on the property. With the succession to ownership by Bralorne Mines work was started on construction of a new mill of approximately 100 tons capacity per day. The new mill was put into operation in the month of February, 1932, and since that date has been in continuous operation, milling an average of slightly over 3,000 tons of ore a month.

The ore treated in the Bralorne mill is a gold-bearing quartz containing a very small amount of silver. About 75 to 80% of the gold is in the form of free gold, the principal remaining portion being intimately associated with pyrite and arsenopyrite. The gangue rock is quartz, together with varying but relatively small amounts of altered diorite or albitite. In some of the ore, usually the higher-grade portions, there is also considerable talc, which forms much slime in grinding.

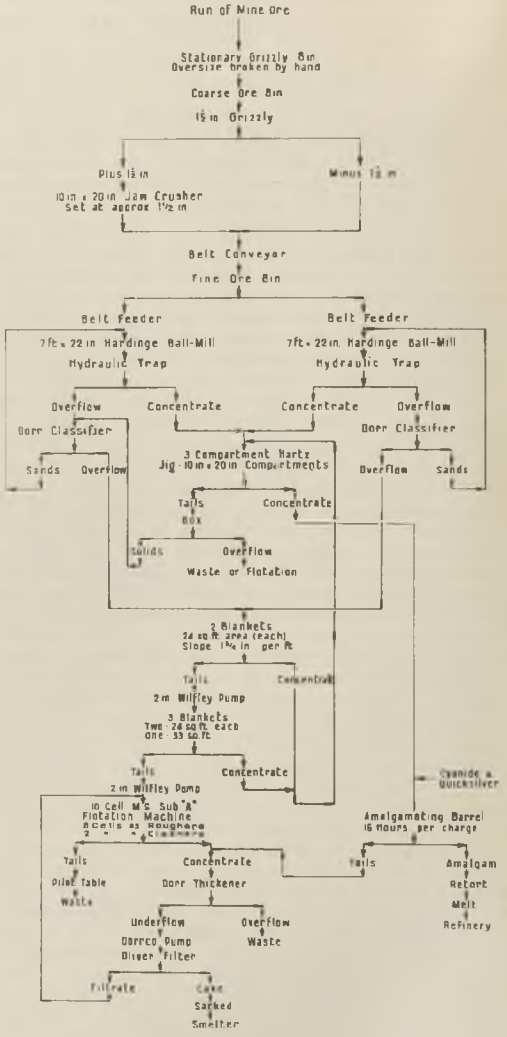
The mill is situated near the portal of the main haulage tunnel and the ore is received directly from the mine ore-trains, which dump on to the grizzly over the coarse-ore bin of the crushing plant. The accompanying figure shows the flow-sheet of the mill as it is now being operated. Various changes have been made in the flow-sheet and in the reagents since the commencement of operations and doubtless minor changes will continue to be made in order to increase the efficiency of the mill.

Among the more important changes were those from two-stage to single-stage grinding and from amalgamation plates to blankets. The change in the crushing was made because too much crushing was done when both primary and secondary mills were employed. Sufficient grinding is done with single-stage grinding, production of slime is minimized, with resulting steadier operation of the flotation plant and a better recovery. The change from plates to blankets was made for various reasons. Considerable difficulty was encountered with oxidation of the plates, which not only meant much additional labour, but also caused a very appreciable reduction in the saving of free gold during such periods. Blankets recover almost as large an amount of free gold as did the plates under the best conditions and they are always in good condition. Moreover, by use of blankets, no mercury is introduced into the mill circuit and thus the presence of amalgam or partly amalgamated free gold in the flotation feed is avoided. Amalgam or partly amalgamated free gold do not respond readily to flotation, while clean free gold in a finely-divided state does. Hence the change has resulted in a very substantial saving in tailing losses.

Operation of the flotation plant has shown that the degree of grinding has a very important influence on the tailing losses. The classifiers are adjusted to deliver a product to flotation of approximately the screen analysis shown in Table 1. Any considerable variation from this analysis, either coarser or finer, results in increased tailing losses. When grinding is much finer, the slime content in the flotation feed is too great. It may be possible to correct the slime condition with proper dispersion agents, but so far efforts in this direction have been unsuccessful.

TABLE 1.

On 80 mesh	.	.	.	15·7% by weight
Through 80 on 100 mesh			.	10·5 ,, ,,
,, 100 ,, 150	,,		.	13·2 ,, ,,
,, 150 ,, 200	,,		.	8·9 ,, ,,
,, 200 mesh	.	.	.	51·7 ,, ,,



The jig was installed in June (1932) for the treatment of the hydraulic-trap material and is giving very good service. It operates only on day shift and at present is treating blanket concentrates as well as the trap material. It produces a high-grade concentrate and low tailing on the trap material and reduces the amount to be treated in

the amalgamating barrel to a relatively small amount. A drag classifier is being installed for the re-treatment of the blanket concentrate prior to treatment in the amalgamating barrel, but it is still in the experimental stage and therefore little can be said of it. Its purpose is to replace the jig in the re-concentration of the blanket concentrate, as the jig is not very efficient on such fine material. The jig will continue to be used for treatment of the trap material.

Various flotation reagents have been used and experiments are continually being made with others and with various combinations of them. Flotation is operating quite successfully in this flow-sheet, but of course, due to haulage and freight costs of the concentrate, there is yet a question as to what will be the ultimate decision regarding it. Perhaps flotation concentrates will ultimately be cyanided.

The average recovery since the mill started has been 93·9% of the gold in the heads, but during the last two months it has been increased to over 95% distributed approximately as follows :—

Amalgamation (traps and blankets) . .	74%
Flotation	21%

No exact figures are available as to the distribution of recovery between the traps and the blankets, but it is estimated that 45–55% of the gold in the mill-heads is recovered by the traps and 20–35% by the blankets. The recovery of gold in the flotation heads by flotation is approximately 80%. The ratio of concentration during the entire period of operation is 43 : 1, while with the present increased recovery it has dropped to about 36 : 1. Test work is now being carried on to increase the ratio of concentration while still making the 95% recovery.

MATACHEWAN GOLD AREA, ONTARIO

A preliminary report by W. S. Dyer on the Matachewan gold area, Ontario, has been issued by the Provincial Department of Mines. The author says that the recent entry of the Hollinger Consolidated Gold Mines, Ltd., and Ventures, Ltd., into the Matachewan area has directed fresh interest to this old camp. The Hollinger held an option on the Young-Davidson deposit in Powell township and, after intensive sampling, took over this property from the original company on August 10 this year. They expect to start work soon on the erection of a mill. Ventures, Ltd., hold an option on the Matachewan Canadian property (old Otisse claims) adjoining the Young-Davidson on the east and are at present actively carrying on development work by drifting and diamond drilling.

Attention was first drawn to the Matachewan area by the discovery in 1916 of gold on the Young-Davidson claims and shortly afterwards on the Otisse claims. Following these discoveries the area was surveyed geologically by Dr. A. G. Burrows and Dr. H. C. Cooke, but since their work was completed development work has been done on many claims and gold discoveries have been made at several widely-distributed localities. The country has also been burned over, uncovering rocks which had formerly been buried under moss and forest growth. Access to the area has been greatly facilitated by the motor road from Elk Lake through Cairo and Powell to the Ashley gold mine in Bannockburn township. This construction work was completed in 1932. Geological field-work during the past summer comprised the detailed examination of Powell and Cairo townships, especially that part which extends from the Young-Davidson claims east for 2 miles to the Montreal River, and from Davidson Creek north for 1 mile. This is the most intensively-developed part of the Matachewan gold area with the exception of the Ashley gold mine. Considerable time was also spent in Baden township and visits were made to the Ashley mine and to certain properties in Holmes and Flavelle townships.

General Geology.—Short descriptions of the geological formations encountered in the Matachewan area, in ascending order, follow :—

Keewatin.—The Keewatin formation consists of a series of flows alternating with beds of agglomerate and tuff. These rocks occupy the major part of Powell and Baden townships and also large parts of Cairo and Alma. They extend westward into Bannockburn and Argyle townships and eastward into Holmes. In Powell and Cairo, particularly south of the Timiskaming sediments, they have been greatly disturbed, sheared, and altered, but in Bannockburn and Baden they are more massive. Tuffs and agglomerates predominate in Baden and Alma, whereas in Powell and Cairo the flows predominate.

Timiskaming.—Two synclinal bands of Timiskaming sediments were followed from west to east across Powell township and into Cairo township. Each of these bands averages 1 mile in width and they are separated by an anticline of Keewatin volcanics averaging 1½ mile in width. The synclines are interrupted by faults on both branches of the Montreal River. The southern band consists largely of conglomerate and conglomeratic quartzite, whereas the northern band consists of beds of finer quartzite and banded quartzites and argillites.

Algoman.—The largest intrusive mass of Algoman age in the area in which detailed work was done consists essentially of red hornblende-syenite which occupies an area of 12 square miles in the north-eastern part of Cairo township and which extends into Holmes, Flavelle, and Alma townships. Intrusive dykes and stock-like masses of porphyry and syenite of greatly varied type and size are very abundant and widely distributed throughout Powell and Cairo townships, and many also occur in Baden, Alma, and Holmes. Very little granite occurs in Powell and Cairo townships. One mass extends for a distance of ½ mile into Cairo from the south and another mass occupies 2 square miles in the west central part of Powell township. Other larger masses are located in the northern part of Baden and Alma townships.

Matachewan.—Diabase dykes, which cut all the rocks older than the Cobalt conglomerate, form a very interesting series in the Matachewan area. They are exceedingly numerous, reach considerable widths (one was seen measuring 700 ft.), and usually run in fairly straight and parallel courses, about N. 10° E. They are most numerous between

the two branches of the Montreal River, where they follow one another with great regularity and in places comprise more than half of the total amount of outcropping rocks. The Matachewan dykes are characterized by large phenocrysts up to 2 in. in diameter of greenish altered felspathic material.

Cobalt Series.—These beds, which consist of poorly-sorted basal conglomerates, followed upward in places by argillites, greywackes, and, rarely, reddish arkose, are best seen in the southern part of Powell township, but also occur in parts of Cairo. They extend westward into Bannockburn and eastward into Flavelle and an isolated outcrop was seen on the "Thesaurus" property on the northern boundary of Baden township.

Keweenawan.—At least one diabase dyke was found cutting the Cobalt conglomerate and hence is of Keweenawan age. This dyke can be seen from the road ¼ mile west of Moyneur's hotel. In the field it appeared to contain a greater quantity of felspar of lighter colour than the Matachewan dykes and did not show the large phenocrysts so characteristic of the latter. The strike of the dyke was approximately north-east in contrast to the nearly north strike of the Matachewan dykes.

Structural Geology.—The structure in Powell and Cairo townships consists essentially of two, east-west trending, closely folded, synclines of Timiskaming sediments lying within the Keewatin volcanics. The southern incline is overturned with dips of about 70° to the south; otherwise the dips, both in the Timiskaming and the Keewatin, are nearly vertical. Two major faults were found, both of them striking nearly north and south, and each following closely the course of the west and east branches of the Montreal River. Other faults with the same strike are indicated by topographic features and there is evidence that some of the Matachewan diabase dykes followed similar faults. Faults found in the Ashley mine are of this type.

The movement on these faults appears to have been mainly vertical and at least one of them (east branch Montreal River) was determined to have been formed after the intrusion of the Algoman porphyry, but before the intrusion of the Matachewan diabase. These north-trending faults do not appear to be numerous, however, and none were definitely found cutting the Young-Davidson or Matachewan Canadian ore deposits.

Much shearing and compression faulting with minor displacement, both pre- and post-ore, were found throughout the area with strikes varying from east to north-east; none of them, however, showed more than a few feet of displacement. In general it is believed that during Algoman time compressive stresses were active from the south, which caused shearing and minor faulting in an easterly direction, and that late in this period normal tension faults trending north (at right angles to the shear) developed.

The report concludes with a description of the various gold properties in the area.

Silver Anniversary Number.—The October issue of the *Chemical Engineering and Mining Review* of Melbourne is of a special nature and is intended to celebrate the completion of the journal's 25th year of publication.

SHORT NOTICES

Open-Pit Blasting.—Details of a large blast carried out at Flin Flon in September last are given by M. A. Roche in the *Canadian Mining Journal* for November.

Blasting Technique.—Blasting rounds suitable for varying types of ground are discussed by Dr. A. Weddige in *Glückauf* for November 25.

Rolls.—A new method of installing roll-shells developed at the International Nickel Co.'s smelters at Copper Cliff, Ontario, is described by W. E. Gillespie in the *Canadian Mining Journal* for November.

Air-Conditioning.—H. G. Moulton discusses the present status of air-conditioning and its potential effect on the mining industries in *Mining and Metallurgy* for November.

Flotation.—In the *Chemical Engineering and Mining Review* of Melbourne for October 5 the practice of flotation is discussed by G. B. O'Malley.

Low-Temperature Reduction of Iron Ores.—The applicability of low-temperature reduction to certain Ontario iron ores is discussed by J. R. Gordon and O. W. Ellis in the *Canadian Mining and Metallurgical Bulletin* for November.

Copper in Nickel Mattes.—In *Metall und Erz* for November 2 the recovery of copper from nickel matte by cementation is discussed by Dr. W. Savelsberg.

Broken Hill Metallurgy.—A description of 25 years' progress in metallurgy at Broken Hill is given by M. R. McKeown in the *Chemical Engineering and Mining Review* of Melbourne for October 5.

Pipe-Lines Underground.—Methods of protecting underground pipe-lines against soil action are discussed by K. H. Logan in *Chemical and Metallurgical Engineering* for October.

Seismic Prospecting.—The analysis of seismic profiles is discussed by I. Roman in Contribution No. 64 to the American Institute of Mining and Metallurgical Engineers for November.

Fine Gold.—T. H. Hite describes special features of fine gold from the Snake River, Idaho, in *Economic Geology* for November.

Magnetite in New Jersey.—In *Economic Geology* for November the occurrence of magnetite ores in Northern New Jersey is described by L. L. Smith.

McIntyre Porcupine Mines.—A description of the varied phases of mining at McIntyre Porcupine Mines, Ltd., is given in the issue of the *Engineering and Mining Journal* for November.

Mount Lyell.—R. M. Murray describes the development of mining and the treatment of copper ores at Mount Lyell, Tasmania, in the *Chemical Engineering and Mining Review* of Melbourne for October 5.

Placer Gold in Quebec.—In the *Canadian Mining Journal* for November W. M. Goodwin describes the Ditton gold placers of South-Eastern Quebec.

Kent Coalfield.—Contributions to the geology of the Kent coalfield by H. G. Dines, Dr. R. Crookall, and Dr. C. J. Stubblefield appear in the Summary of Progress of the Geological Survey of Great Britain for 1932, Part II.

Wages in the Mineral Industry.—Wage costs in the mineral industries are discussed by P. M. Tyler in *Mining and Metallurgy* for November.

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.*

9,290 of 1932 (399,475). A. D. HADSEL, Oakland, California. Ore reduction machine in which the ore is dropped on to a non-rotating impact bed from which it is continuously removed for retreatment.

14,311 of 1932 (399,597). J. TONGE and K. J. TONGE, Bolton. Hydraulic mining cartridges for breaking down coal or other substances.

17,833 of 1932 (400,346). GENERAL ELECTRIC Co., London. Sand flotation process for the cleaning of coal.

19,127 of 1932 (398,980). C. B. THORNE, Hawkesbury, Ontario. Long fibres in aqueous suspension are removed in a rotating screen provided with means for maintaining a forward flow of the fibres retained on inside of the screen.

19,626 of 1932 (399,294). H. HEIDENREICH, Mährisch-Ostrau, Czecho-Slovakia. Minerals of different specific gravity are separated on a table in which supporting grate bars alternately rise and fall in parallel planes without horizontal displacement.

20,851 of 1932 (399,297). DORR CO., INC., New York. Improvements in sedimentation apparatus of the type in which the settled sludge is raked towards a central discharge.

4,171 of 1933 (399,382). FRIED. KRUPP GRUSONWERK A.-G., Magdeburg-Buckau, Germany. Iron sponge used wholly or partially as fuel in apparatus for sintering fine ores or metallurgical products is found to form a firm sintered product easy to handle in subsequent operations.

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 Economics of Mining : Valuation, Organization, Management. By T. J. HOOVER. Cloth, octavo, 547 pages, illustrated. Price $6 00. California : Stanford University Press. London : Humphrey Milford, Oxford University Press.

Applied Geophysics in the Search for Minerals. 2nd edition. By A. S. EVE and D. A. KEYS. Cloth, octavo, 296 pages, illustrated. Price 16s. London : Cambridge University Press.

Principles of Metallurgy. By D. M. LIDDELL and G. E. DOAN. Cloth, octavo, 626 pages, illustrated. Price 30s. London : McGraw-Hill Publishing Co.

Geology of California. By RALPH H. REED. Cloth, octavo, 355 pages, illustrated. Price $5·00. Tulsa, Oklahoma: American Association of Petroleum Geologists. London : Thomas Murby and Co.

Handbook of Prospecting. 3rd edition. By Dr. W. L. GOODWIN. Cloth, pocket size, 367 pages, illustrated. Gardenvale, Quebec : Industrial and Educational Publishing Co.

Schwefel-Graphit-Jod-Bor-Magnesit-Talk. By Dr. O. STUTZER, Dr. W. WETZEL, and Dr. A. HIMMELBAUER. Die Wichtigsten Lagerstätten der "Nicht-Erze," Bd. V. Paper covers, 396 pages, illustrated. Price RM. 30. Berlin : Gebrüder Borntraeger.

Mineral Industry of the British Empire and Foreign Countries. Imperial Institute Statistical Summary (Production, Imports, and Exports) 1930–1932. Paper covers, 429 pages. Price 6s. 6d. London : H.M. Stationery Office.

Firedamp : Ignition of Firedamp by the Filaments of Broken Electric Lamp Bulbs. By G. ALLSOP and T. S. E. THOMAS. Safety in Mines Research Board Paper No. 80. Paper covers, 13 pages, illustrated. Price 6d. London : H.M. Stationery Office.

Ontario : Mining Laws and the Department of Mines, 1933. Cloth, large octavo, 141 pages, illustrated. Toronto : Department of Mines.

Western Australia. Department of Mines Report, 1932. Paper covers, folio size, 67 pages, illustrated. Perth : Department of Mines.

Alabama : Iron ore in the Red Mountain Formation, Greasy Cove. By E. F. BURCHARD. United States Geological Survey Circular 1. Paper covers, typescript, 49 pages, with map. Washington : Superintendent of Documents.

Oregon : Copper Deposits in the Squaw Creek and Silver Peak districts and at the Almeda mine, Southwestern Oregon, with notes on the Pennell and Farmer and Banfield prospects. By P. J. SHENON. United States Geological Survey Circular 2. Paper covers, typescript, 35 pages, illustrated. Washington : Superintendent of Documents.

Bleaching Clays. By P. G. NUTTING. United States Geological Survey Circular 3. Paper covers, typescript, 51 pages, illustrated. Washington : Superintendent of Documents.

Montana. Some Deposits of Ornamental Stone. By G. R. MANSFIELD. United States Geological Survey Circular 4. Paper covers, typescript, 22 pages, illustrated. Washington : Superintendent of Documents.

Salt Domes : Origin of the Anhydrite Cap Rock of American Salt Domes. By M. I. GOLDMAN. United States Geological Survey Professional Paper 175-D. Paper covers, illustrated. Price 15 cents. Washington : Superintendent of Documents.

Potash. By B. L. JOHNSON. United States Bureau of Mines Economic Paper 16. Paper covers, 78 pages. Price 10 cents. Washington : Superintendent of Documents.

Mineral Resources of the United States, 1930. Part 11—Non-metals. Cloth, 876 pages. Price $1·50. Washington : Superintendent of Documents.

The Boom in "Kaffirs"—An Analysis.—By Professor C. S. RICHARDS. Paper covers, 27 pages, illustrated. Price 2s. 6d. Johannesburg : Hortors, Ltd. London : Technical Bookshop.

An Introduction to the Heating and Ventilating of Buildings.—By W. E. WILLIAMS. Paper covers, 45 pages, illustrated. Price 2s. London : Draughtsman Publishing Co.

And This is Mining!—By FESTINA LENTE. Cloth, octavo, 137 pages, illustrated. Price 3s. 6d. London : Crosby Lockwood, Ltd.

COMPANY REPORTS

Van Ryn Gold.—This company was formed in 1894 and works a gold-mining property on the Far East Rand. The report for the year to June 30 last shows that 611,000 tons of ore was milled, yielding 129,670 oz. of gold, worth £664,802. Working costs amounted to £507,109 and the working profit to £157,693, sundry revenue bringing

the total profit up to £197,054. After making all allowances and adding the sum brought in from the previous account there was an available total of £167,533, of which £75,000 was distributed as dividends, equal to 15%. The ore reserves at the end of the year were calculated on the standard price for gold and totalled 382,200 tons, averaging 3·9 dwt. over a stoping width of 38 in. With gold at 120s. per oz. a further 732,700 tons, averaging 2·6 dwt. over 46 in., comes within the payable limit, giving a total reserve of 1,114,900 tons, averaging 3·0 dwt. over 43 in. In view of the improved outlook at the mine owing to the higher price now being obtained for gold certain plant additions have been authorized which are expected to increase its capacity and efficiency.

Messina (Transvaal) Development.—This company, formed in 1905, works copper properties in the Zoutpansberg district of the Transvaal. The report for the year to June 30 last shows that 405,706 tons of ore, averaging 2·35% copper, was mined, the tonnage treated at the mill being 404,473. The smelting plant produced 9,463 tons of ingots, averaging 99·89% copper. The accounts show a profit of £13,087, which, added to the sum brought in, gave an available total of £66,343, which was carried forward. The ore reserves at the end of the year were estimated to be 1,142,138 tons proved, averaging 2·40% copper, and 23,576 tons of probable ore, averaging 2·29% copper. The ore developed during the year in the Harper mine was 67,881 tons, while 320,117 tons was developed in the Messina.

Namaqua Copper.—This company, formed in 1888, owns copper properties in Namaqualand, Cape Province, South Africa. The report for 1932 shows that during the year 43 tons of copper precipitate was produced, estimated to contain 55·5% copper. The accounts show a loss of £1,357, increasing the debit balance brought in to £39,329. Sales of plant during the year realized £1,981. An option to acquire a large interest in an Italian property was exercised in February of the current year and the development of this mine is said to have been restarted on an extended scale.

Rhodesian Corporation.—This company, formed in 1924, owns gold-mining properties in Southern Rhodesia and holds important interests in other ventures. The report for the year to July 31 last shows that over a period of 22 months the Fred mine treated 45,990 tons of ore for a yield of 23,972 oz. of gold. The revenue from these operations was £141,892 and the profit £59,954. The reserves of ore at this mine at July 31 last were estimated to be 125,420 tons, averaging 8·6 dwt. in value. During the period under review the Turkois mine has been let on tribute, the interest in Wanderer Consolidated has been retained, and the interest in the mineral rights of Maraisdrift disposed of to East Rand Consolidated. The accounts of the corporation for the period under review show a profit of £72,877, increasing the sum brought in to £88,250. After making all allowances there was £15,511 to be carried forward.

Jantar Nigeria.—This company was formed in 1912 and works alluvial tin properties in Northern Nigeria. The report for the year to September 30 last shows that the output of tin concentrates was 120·5 tons, the amount allowed the company under the restriction scheme. The average price realized for tin sold, however, was £181 2s., as compared with £127 15s. 6d. for the output of the previous year. The accounts show a profit of £7,709, increasing the sum brought in to £28,119, of which £6,750 has been distributed as a dividend, equal to 5%, £5,502 applied to depreciation, and the balance of £15,867 carried forward.

Nigerian Consolidated.—This company was formed in 1920 and works alluvial tin properties in Northern Nigeria. The report for the year to March 31 last shows that under restriction conditions the company's output of tin concentrates amounted to 66 tons. The year's operations resulted in a profit of £1,460, increasing the sum brought in to £13,084. Against this £1,515 has been allowed for plant depreciation and other items, while the cost of the expedition to Tanganyika, amounting to £17,045, has also been written off, leaving £5,456 at debit of profit and loss.

West African Diamond.—Formed in 1923, this company works alluvial diamond properties in Gold Coast Colony. The report for the year to March 31 last shows that by treating a larger yardage the company produced 13,455 carats more than in its previous year's work at a reduced cost per carat. The accounts show a profit of £26,528, against £18,655 in the previous year.

Associated Gold.—This company was formed in 1925 and works a gold-mining property on the Coolgardie goldfield, Western Australia. The report for the year to March 31 last shows that 63,309 tons of ore was treated, yielding gold to the value of 23s. 2d. per ton. The gold premium yielded £29,908, £25,103 was realized on exchange, and £2,859 was obtained as gold bounty. Working costs amounted to 31s. 1d. per ton, a reduction of 5d. per ton as compared with the previous year. The accounts show a profit of £16,615, which, added to the sum brought in, gave an available total of £34,111. Of this amount £29,768 is to be distributed as dividends, equal to 1s. per share, and, after making other allowances, £3,896 remains to be carried forward.

Golden Horse Shoe (New).—This company was formed in 1929 and is treating the tailing dumps of the old Golden Horse-Shoe mine at Kalgoorlie, Western Australia. The report for the year to September 30 last shows that 478,620 tons of tailings was re-treated, yielding gold (at standard value) equal to 3s. 2d. per ton, treatment costs amounting to 2s. per ton. In addition £59,834 was received on account of the gold and exchange premiums, while gold bounty amounting to £2,997 was also paid. The accounts show a profit of £25,314, increasing the sum brought in to £63,426. Of this amount dividends equal to 1s. per share will absorb £55,000 and, after making other allowances, there will be a balance of £8,426 to be carried forward. The balance remaining in the dumps at the end of the year was estimated to be 1,007,983 tons, equal to two years' supply at the present rate of treatment.

Pahang Consolidated.—This company, formed in 1906, works lode-tin properties in the State of Pahang, Malaya. The report for the year to July 31 last shows that 188,400 tons of ore was treated, yielding 2,526 tons of black tin, while, in addition, 53 tons was recovered from alluvial. The price realized per ton of concentrates was £143 and the mines profit for the year was £20,372, increasing the sum brought in to £50,510. Of this amount preference dividends will absorb £7,000 and, after making allowances for depreciation and other items, there will be £37,522 to be carried forward.

Tekka.—Formed in 1920, this company works alluvial tin property in the Kinta district, F.M.S. The report for the year to March 31 last shows that the output of tin concentrates, under restriction conditions, was 161·76 tons, worth £13,238. The accounts show a profit of £8,538 and, after writing off £4,500 from the plant and property account, there was £4,037 to be added to the sum brought in, increasing it to £26,408. A dividend equal to 3d. per share absorbed £4,482, leaving £21,926 to be carried forward.

Kamunting Tin.—Formed in 1913, this company works alluvial tin property in the Larut district, Perak, F.M.S. The report for the year to June 30 last shows that the total output was 1,287 tons of tin ore, worth £132,657. The accounts show a profit of £77,418, which, added to the sum brought in, gave an available total of £138,198. Of this amount £70,313 was distributed as dividends, equal to 15%, and £23,581 absorbed as debenture interest and for debenture redemption, leaving £44,304 to be carried forward. During the year 93·8 acres at Pangnga were added to the company's property.

Kepong Dredging.—This company was formed in 1923 and works alluvial tin property in the State of Selangor, F.M.S. The report for the year to June 30 last shows that the dredge was operated during the months of November, 1932, and March and June, 1933, the output permitted by the restriction agreement being obtained in those months. The production totalled 84·68 tons, which realized £8,406. The year's working resulted in a profit of £722, reducing the debit balance brought in to £4,156.

Pattani Tin.—This company was formed in 1930 and operates alluvial tin properties in the Province of Pattani, Siam. The report for the year to June 30 last shows that the total production of tin concentrates amounted to 391½ tons, realizing £107 per ton, the average cost of working amounting to £63 per ton. The accounts show a profit of £15,366, increasing the sum brought in to £20,560. Dividends equal to 7% absorbed £11,895 and, after making other allowances, there remained a balance of £1,959 to be carried forward.

Mawchi Mines.—This company, formed in 1914, works tin and wolfram mines in one of the Southern Shan States, Burma. The report for 1932 shows that 57,848 tons of ore was extracted from the mine and 54,278 tons milled, the yield of tin-wolfram concentrate amounting to 2,540 tons. In addition, 191 tons of concentrates was purchased. Mining operations resulted in a loss of £4,153 and, after making other allowances, there was a total debit of £17,443. The ore reserves at the end of the year were estimated at 60,379 tons, averaging 4·41% Sn and W, fully proved, in addition to 9,108 tons partly-proved ore.

Burma Corporation.—This company was formed in 1919 and works silver-lead, zinc, and copper mines in the Federated Shan States, Upper Burma. The report for the year to June 30 last shows that 351,482 tons of concentrating ore, assaying 23·87% lead, 13·44% zinc, and 19·71 oz. silver per ton, was sent to the mill, where 146,370 tons of lead concentrates, assaying 52·61% lead, 10·99% zinc, and 42·92 oz. silver per ton, and 55,355 tons of zinc concentrates, assaying 53·55% zinc, 5·36% lead, and 8·38 oz. silver per ton, was produced. The refinery output totalled 70,560 tons of refined lead and 6,050,187 oz. refined silver. The accounts show a profit of Rs. 41,71,151, an increase of Rs. 12,98,605 as compared with the previous year. After adding the sum brought in from the previous account there was Rs. 59,68,616 available, of which Rs. 29,62,244 was distributed as dividends, leaving Rs. 30,06,372 to be carried forward. The ore reserves at June 30 last were estimated to be 4,130,748 tons, averaging 25.5% lead, 15.5% zinc, 0·68% copper, and 19·6 oz. silver per ton, as compared with 4,126,179 tons, assaying 25·4% lead, 15·6% zinc, 0·68% copper, and 19·7 oz. silver per ton, at the end of the previous year.

Consolidated Tin Mines of Burma.—Formed in 1928, this company operates alluvial tin-wolfram properties in the Tavoy district, Burma. The report for the year to June 30 last shows that the production of mixed concentrates amounted to 1,144 tons, while 22·4 tons was purchased locally. The all-in cost of production was estimated to be £62 19s. 1d. per ton, while the average price realized per ton of mixed concentrates was £73 12s. 8d. The year's operations resulted in a surplus of revenue over expenditure of £13,301 and this has enabled the debit balance brought in to be extinguished and left £281 to be carried forward.

Anglo-Burma Tin.—This company, formed in 1926, operates alluvial tin properties in the Tavoy and Mergui districts of Lower Burma. The report for the year to June 30 last shows that 73,173 cu. yd. of ground was treated at Heinda, 398·54 tons of tin concentrates being recovered. Tribute ore from Heinda and Thabawleik amounted to 39·58 tons, making a total output of 438·12 tons, as compared with 367·91 tons in the previous year. The accounts show a profit of £10,959 and, after adding the sum brought in, there was an available total of £11,455. Of this amount £6,951 will be absorbed as a dividend, equal to 10%, leaving £4,504 to be carried forward. A hydro-electric plant is to be installed at the property and is expected to be in operation at the commencement of the next monsoon.

Mexican Corporation.—This company was formed in 1919 and is largely interested in the Fresnillo silver mine and in the Teziutlan copper-zinc mine in Mexico. The report for the year to June 30 last shows that at Fresnillo the cyanide mill treated 640,378 dry tons of oxide ore, 149,685 tons of Santa Ana tailings, and 935 tons of custom ore, a total of 790,998 tons, averaging 0·242 dwt. gold and 5·99 oz. silver. The bullion recovered contained 6,744 oz. of gold and 3,115,705 oz. of silver. The concentrator treated by selective flotation 130,467 tons of sulphide ore, averaging 0·23 dwt. gold, 11·71 oz. silver, 8·4% lead, 9·0% zinc, and 1·25% copper, producing 14,217 tons of lead concentrates, 16,946 tons of zinc concentrates, 5,603 tons of copper concentrates, and 3,273 tons of pyrite concentrates. The ore reserves at the end of the year were estimated to be 2,894,074 tons of oxide ore, averaging 0·14 dwt. gold and 4·44 oz. silver, together with 1,183,528 tons of sulphide ore, averaging 0·2 dwt. gold, 9·7 oz. silver, 8·0% lead, 8·4% zinc, and 0·7% copper. The Teziutlan property remained closed down during the year. The accounts of the Mexican Corporation for the period under review showed a loss of £11,912, increasing the debit balance brought in to £29,037.

Trepca Mines.—This company was formed in 1927 and operates a lead-zinc property in Yugoslavia. The report for the year to September 30 last shows that the ore treated amounted to 535,869 tons, yielding 58,852 tons of lead concentrates and 83,297 tons of zinc concentrates, all of which were disposed of under running contracts. The accounts

show a profit of £221,333, increasing the sum brought in to £228,446. Of this amount £178,485 will be absorbed as dividends, equal to 16%, and £40,000 has been placed to reserve, leaving £9,961 to be carried forward. The ore reserves in the Stantrg mine at September 30 were estimated to be 2,500,000 tons, averaging 9·0% lead and 8·5% zinc.

Chinese Engineering.—Formed in 1912, this company owns collieries, land, and harbour works in Northern China. The report for the year to June 30 last shows that the business of the Kailan Mining Administration was severely affected both by world conditions and by the Sino-Japanese conflict in Northern China. The sales of coal during the year amounted to 4,005,000 tons, against 4,888,000 in the previous year, while the selling price per ton was also lower. The company's proportion of the profit of the Kailan Mining Administration was $298,440 and, after allowing for all expenses, there was a net profit of £68,565, the balance available after adding the sum brought in and deducting income-tax being £40,713. A dividend equal to 2½% paid during the year absorbed £49,000, the deficit being met by the transfer of £10,000 from reserve, which now stands at £150,412.

Weardale Lead.—This company, formed in 1900, owns lead mines and smelters at Weardale, Durham. The report for the year to September 30 last shows that 1,260 tons of dressed lead ore and 1,813 tons of fluorspar were produced, the company's operations being carried out on a reduced scale in view of the low price of lead. The accounts show a profit of £188 and, after adding sundry revenue, there was a credit balance of £881 to be carried forward.

British Burmah Petroleum.—This company was formed in 1910 and operates oil wells on the Yenangyaung and other oilfields in Burma, in addition to having interests in oil industries in other parts of the world. The report for the year to July 31 last shows that production was greater than during the previous year, the deepening of certain wells on the Yenangyaung field reacting favourably on the yield. The accounts show a profit of £34,376, increasing the sum brought in to £42,896, of which £41,562 has been appropriated for the debenture sinking fund, leaving £1,334 to be carried forward. In conjunction with the Union Corporation the company is investigating the production of oil from shale and torbanite deposits in South Africa.

DIVIDENDS DECLARED

Akim.—3d., less tax.

Anglo-Burma Tin.—6d., less tax, payable Dec. 9.

Associated Gold.—6d., less tax, payable Dec. 26.

Balaghat.—Pref. and Ord. 1s., less tax, payable Nov. 16 (liquidation dividend).

Blackwater.—1s., free of tax, payable Dec. 15.

Charterland and General Exploration.—Pref. 3%, less tax, payable Dec. 15.

Consolidated Gold Fields of New Zealand.—6d., free of tax, payable Dec. 15.

Consolidated Gold Fields of South Africa.—2s. 3d., less tax, payable Dec. 21.

Frontino Gold.—Pref. 10%, less tax; Ord. 11¼%, less tax, payable Jan. 1.

Golden Horse Shoe (New).—6d., less tax, payable Jan. 30.

Jantar Nigeria.—5%, free of tax, payable Dec. 16.

Kamunting Tin.—6d., less tax.

Kleinfontein Estates.—3½%, less tax, payable Dec. 8.

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

Kramat Tin Dredging.—10%, less tax, payable Dec. 19.

Larut Tin Fields.—3d., less tax, payable Dec. 16.

Lonely Reef.—6d., less tax, payable Jan. 31.

Malayan Tin Dredging.—6d., less tax, payable Dec. 21.

Mount Lyell.—6d. (Australian), less tax, payable Dec. 18.

Pangnga Tin.—13%, less tax, payable Dec. 8.

Rantau Tin Dredging.—Pref. 6%, less tax, payable Dec. 19.

Siamese Tin.—1s. 3d., less tax, payable Dec. 19.

Siberian Syndicate.—2s., less tax, payable Dec. 19.

South American Gold and Platinum.—10 cents, less tax, payable Dec. 12.

Southern Malayan Tin Dredging.—4½d., less tax, payable Dec. 21.

Southern Perak Dredging.—1s., less tax, payable Dec. 21.

Star Explorations.—1½d., less tax, payable Nov. 30.

Tehidy Minerals.—6d., less tax, payable Dec. 6.

Transvaal and Delagoa Bay.—4s. 6d., less tax.

Trepca.—6d., less tax, payable Dec. 11.

Wiluna.—2s., less tax, payable Jan. 15.

Zinc Corporation.—Pref. 2s. 6d., less tax; Ord. 6d., less tax, payable Jan. 1.

NEW COMPANIES REGISTERED

Anglo-European Mining Corporation.—Capital: £100 in £1 shares. Objects: To carry on the business of mine owners, metallurgists, etc.

Arabian Development Syndicate.—Capital: £10,000 in £1 shares. Objects: To secure openings for the employment of capital in Arabia and elsewhere and prospect and test properties capable of containing mineral oils, coal, gold, etc.

Broue and Co.—Capital: £50,000 in £1 shares. Objects: To commercialize inventions of A. E. Broue in connexion with the treatment of titaniferous sands or ores. Directors: Albert Edward Broue and Loretta Mary Broue.

Chiman Goldfields.—Capital: £102 in 1,000 Ordinary shares of 2s. and two Seven per Cent. Preference shares of £1. Objects: To acquire gold mines, gold-mining rights, etc., in Panama and elsewhere. Directors: Frederich W. Kealey and Charles W. Forbes. Office: 4 and 5, Warwick Court, W.C.

Consolidated Collieries.—Capital: £250,000 in £1 shares. Objects: Incorporated in the Transvaal on September 6, 1920, to acquire prospecting rights over part of the Farm Smutsoog, No. 143, in the district of Ermelo, and to carry on business as colliery proprietors, etc. Directors: Jas. H. Crossley, Sir Reginald A. Blankenberg, Roderick L. Innes. British office: 10–11, Austin Friars, E.C. 2.

South African Gold Areas "A."—Capital: £300 in 5s. shares. Objects: To acquire mining rights and to adopt agreements (1) with W. E. Bleloch and (2) with Medley Hartmann and Co. Directors: Edmund W. Janson, Archibald T. Spens, and William E. Bleloch.

Tiger Mines.—Capital: £10,000 in 5s. shares. Objects: To acquire any mines in Southern Rhodesia or elsewhere.