The Mining Magazine

Managing Director and Editor: W. F. WHITE. *Assistants:* ST. J. R. C. SHEPHERD, A.R.S.M., D.I.C., F.G.S.; F. HIGHAM, A.R.S.M., M.Sc., F.G.S.

PUBLISHED on the 15th of each month by MINING PUBLICATIONS, LIMITED, AT SALISBURY HOUSE, LONDON, E.C. 2.

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

BRANCH OFFICES { New York: Amer. Inst. M. & M.E. Chicago: 360, N. Michigan Blvd. San Francisco: 681, Market.

SUBSCRIPTION { 12s. per annum, including postage. U.S.A., $3 per annum, including postage.

Vol. XLIV. No. 6. LONDON, JUNE, 1931. PRICE ONE SHILLING

CONTENTS

EDITORIAL

ON June 8 Lord Rutherford opened the new headquarters in London of the British Non-Ferrous Metals Research Association, to the removal of which from Birmingham reference was made in the MAGAZINE for September last.

THE 1931 edition of Skinner's "Oil and Petroleum Year Book" was published last month. The book contains, as usual, up-to-date particulars of all the principal oil companies in the world and tends to become more and more an international work of reference.

ON May 22 the American Institute of Mining and Metallurgical Engineers celebrated its 60th anniversary by meeting at Wilkes-Barre, Pennsylvania, where it was originally organized. Members attending the celebration were entertained by the Anthracite Section of the Institute.

THE Birthday Honours contain at least two names of interest to the mining profession. Sir William Bragg, whose work on the structure of crystals has been of such great importance to metallurgists and mineralogists, receives the O.M. and and Mr. J. B. Scrivenor, director of the Geological Survey of the F.M.S., the I.S.O.

IN the autumn an exhibition will be held in Sheffield, under the auspices of the Coal Face Machinery Exhibitors' Association, which should do much to extend the knowledge of coal-face machinery among the colliery operators of this country. The exhibition will last from October 2 to 10, and most British firms engaged in this type of work will be represented.

A NEW method for the recovery of cyanide from leaching solutions or waste mill liquors produced in normal practice by cyanidation of gold and silver ores has been devised by Mr. H. T. Durant and Messrs. Sulman & Picard, in association with the General Engineering Company, and is likely to prove of considerable interest to those engaged in cyaniding operations. It not only provides for the recovery of the residual cyanide carried by weak liquors or foul solutions but introduces improvements in the precipitation of the metal values. We understand the process to be especially suited to the treatment of foul liquors; hence certain complex ores not hitherto readily amenable to cyanidation may now come within its scope.

THE maiden speech of Lord Rutherford in the House of Lords admirably dealt with the present position with regard to oil from coal in this country. His lordship pointed out that the development of carbonization and hydrogenation offer great advantages, but that, as has been stressed in these columns, the present problems are economic, natural oils being to-day available in great quantities and at low prices. He remarked that progress in carbonization depended on how far the nation was prepared to pay for a purer atmosphere by using cokes instead of coal. In this respect a recent letter of Sir Richard Redmayne's to the press may be quoted, in which the advantages of the development of low-temperature carbonization processes in conjunction with electrical power-stations were pointed out, such locations enabling a ready sale to be found for the gas and coke, two of the process-products which must be sold.

The Institution's Annual Meeting

The Empire Congress held last year in South Africa made such calls on members' time that two alterations had to be made in the annual programme of the Institution of Mining and Metallurgy, the first being the abandonment of the dinner, to which reference was made last month, and the second the postponement of the general meeting until June. This year it was possible once again for members to meet about the usual time in May and the annual gathering was well attended. Special reference should be made to the presence on this occasion of the High Commissioner for Canada, Mr. G. Howard Ferguson, who had come in order to receive the gold medal on behalf of Dr. Charles Camsell.

The retiring president, Mr. J. G. Lawn, in presenting the annual report of the Council and the accounts for the year, made special reference to the proposed

review of the mineral resources and industries of the Empire, the appointment of a committee for this purpose, under the chairmanship of Sir William J. Larke, having been announced at the dinner held in April. He briefly reviewed the scope of the proposed investigation and emphasized that the aim of the committee would be to draw up plans to which work in the various parts of the Empire might conform and to leave the details to be filled in by the appropriate governments and local institutions. Coming to the presentation of the Institution's awards, the president regretted that Dr. Camsell, who is Deputy-Minister of Mines and Industries for the Dominion of Canada, was unable to be present, but said he was glad that the High Commissioner had been able to attend in order to accept the medal on Dr. Camsell's behalf. After referring at some length to the great progress which had been made in the development of Canada's mineral resources, he pointed out the important work that had been done by the recipient in helping to frame the wise and statesman-like mining laws and regulations of Canada and in giving active encouragement in the opening-up of the Dominion's resources. Mr. Ferguson, in accepting the medal, made reference to the fact that it had once previously been presented to a Canadian, Dr. W. G. Miller, then head of the Geological Department of Ontario, and said that he felt that perhaps these two men had given the leadership and inspiration which had been responsible for much of Canada's rapid growth as a mineral producing country. As to the other awards only Mr. E. G. Lawford was able to be present, so that Professor S. J. Truscott accepted the Consolidated Gold Fields of South Africa's Gold Medal on behalf of Mr. C. W. B. Jeppe and the "William Frecheville" prize for Mr. W. H. Wilson, remarking that he felt some pride in the fact that each of these three recipients had been students of his own. The motion for the adoption of the report and accounts was seconded by Mr. Edgar Taylor, who made reference to the financial stability of the Institution and to the satisfactory maintenance of membership and went on to say that he felt that such stability was the best means of enabling members to see that there was—in the words of Sir Auckland Geddes at the annual dinner—"no pause in the search for efficiency" in the work of the profession. The motion was supported by Mr. E. T. McCarthy and, after remarks from several other members, it was carried. The usual vote of thanks to the retiring president having been passed, Mr. Lawn inducted the new president, Mr. W. Pellew-Harvey.

The final business of the evening was the delivery of his inaugural address by the new president, who chose as his subject "Reflections on the relative effect of the fall in metal prices on base-metal mining compared with that of gold." In the course of his paper Mr. Pellew-Harvey refers to the question of the responsibility of gold shortage or maldistribution for the present economic depression through which the whole world is, we hope, just passing. He points out that gold stocks in France and the United States of America have not, at any rate, prevented conditions which are similar to those experienced in other countries and emphasizes the fact that, while the gold standard, so widely adopted, gives that metal the property of providing credit for all enterprises, the base metals give infinitely more actual employment in the workshop, the warehouse, and the office than does gold and that they must legitimately be considered as necessities for the progress of civilization. The paper then goes on to review the present state of the industries concerned with the principal metals and we understand that had time permitted more extended reference would have been made to the Cornish mining industry, the new president himself being a Cornishman. The review concluded, the effect of the decline of metal prices on the profits of companies engaged in the industry is next examined and the extensive work which will be necessary to enable mining and metallurgical enterprises to meet declining prices by reductions in production costs is emphasized. In concluding his address, Mr. Pellew-Harvey lays especial stress on the necessity for thorough training for those about to enter the profession and points out that, in spite of the present bad times, the supply of these base-metal necessities of mankind must be continued and, in view of the world's growing population, must, indeed, expand, so that efforts to meet present conditions by the search for more efficient means of production are bound to have their reward in the future. The paper, it may be said, is one which will amply repay the study which we feel is necessary for its assimilation.

The Royal School of Mines Dinner

The 54th annual dinner of the Royal School of Mines held this month under the auspices of the Old Students' Association differed from many previous ones. It has been usual to regard this function as a purely family gathering, the guests invited generally having some connexion with the School. This year, however, it was marked by the presence of principal guests whose connexion is rather with big business than education, these including Sir Francis Goodenough, a prominent figure in the industrial world, and Sir Auckland Geddes, chairman of the Rio Tinto, and there is little doubt that the innovation is a wise one, for these are the people who should have a just appreciation of the type of men turned out by the School. Many familiar faces were seen and a happy spirit of re-union pervaded the gathering.

In the past two years the speeches following the dinner have dwelt much on the training of the engineer and the connexion between graduate-supply and industry. This year, however, it was soon evident that weighty pronouncements on this or other problems were to be conspicuous by their absence; in short, a veto had been laid on the high-brow and all talk was to be light and airy. Sir Francis Goodenough, for instance, who proposed the toast of the School. expressed his relief at the fact that, after he had initiated a search for suitable material on which to speak, he had received a note from the secretary of the Old Students' Association intimating that there was a general desire for speeches which should not tax the attention of the hearer, and later other speakers revealed that this had also been their experience. In a short but amusing speech, therefore, Sir Francis proposed his toast and expressed his pleasure at having been present. In responding for the School, the president of the Old Students' Association, Major W. M. Henderson-Scott, referred to the previous speaker's connexion with salesmanship and expressed a hope that he might be able to do something for the base metals. He next dwelt lightly on the training at the R.S.M. and the attractions of a career in such a glorious profession, expressing a hope that present students would have as little difficulty in finding employment as had been the case in his own day. Turning to the question of a new register of the association, which is being compiled by Professor Truscott, the president emphasized their debt to their honorary secretary, not only for undertaking such a task, but for the great help he was only too willing to give on all occasions. Finally, he besought his hearers to remember that, good as was the training at the School, it was the desire to learn, already ingrained in the young man, which was the most important factor in the climb to success.

The pleasant task of proposing the toast of "Our Guests" fell to Mr. G. W. Gray, who took the opportunity of reminding those present that Agricola had called mining "a calling of peculiar dignity." He then referred to many of the guests by name and expressed his pleasure at the presence of the headmasters from several of the London public schools, venturing to suggest that the R.S.M. needed the best material the schools could offer. In responding, Sir Auckland Geddes made light of bad times which permitted his hosts to offer him such a meal, suggesting rather that it was company chairmen who were suffering. In serious vein, he pointed out that the world was not yet coming to an end, that bad times would pass, and that, in the not too distant future, they would be clamouring for base metals. Here he was disposed to offer a gentle warning to those happy to be engaged in gold mining and reminded them that there were suggestions abroad for the replacement of the gold standard. Sir Auckland concluded by acknowledging his debt to those who, trained at the School, had been of such great assistance to him. The final toast of the evening, that of the chair, was proposed by Mr. Arthur Dickinson, who was able to sketch something of Major Henderson-Scott's career up to the time he had been in charge of the Mineral Resources Bureau, and it met with a whole-hearted response.

The Passing of the I.M.M. Sieve

There is a possibility that some members of the Institution on receiving their copy of the annual report may fail to notice what is unquestionably an item of the greatest importance. It will be recalled that extended reference was made in these columns in September last to the question of the standardization of sieve sizes, particular attention being paid to a new series proposed by the British Engineering

Standards Association, generally known as the B.E.S.A. series. Last month we noted the publication of the official specification for this new series of sieves and, in the interests of uniformity, the Council of the Institution has now decided to discard the I.M.M. series and adopt that of the B.E.S.A. It will possibly be a matter of surprise that the Council's decision should have been made without giving members an opportunity of discussing the question and on these grounds the position seems to be one which warrants fresh examination.

The old I.M.M. series became available in 1907, its adoption being generally welcomed after the whole matter had been discussed at several meetings of the Institution, and it has been widely used for testing purposes in this country, Australia, and South Africa, although Canada preferred the Tyler system, which is almost universal in the United States. It will be recalled that the principle of the I.M.M. series was that the mesh number should be in exact proportion to the aperture size, which is given in terms of the inch, each successive member of the sieve series being a round fraction of the unit. This was secured by making the linear dimension of the aperture equal to the diameter of the wire, so that, to repeat a quoted example, a 20-mesh screen had 20 apertures and 20 wires to the inch, each aperture being $\frac{1}{40}$ of an inch. It is true that the available screening area of the sieves was only 25 per cent. of the whole on this arrangement and that their manufacture was somewhat expensive, although for testing purposes this was not of the greatest importance, as accuracy was assured over a long sieve-life. For commercial screening, however, these were definite disadvantages. It is evident, nevertheless, that the fact that the mesh bore a definite relation to product-size was a feature of the greatest importance, as to speak of a mesh-number was enough to give an accurate impression of the size of product. The new I.M.M. series was prepared with great care by the two delegates of the Institution on the B.E.S.A. committee which was examining the question of sieve-size standardization, and they fully recognized the disadvantages of the old series for commercial work, their new series having characteristics which, we feel, should have been more widely recognized. Realizing that the screening area would have to be increased, which would involve a loss of some of the long accurate life enjoyed by the old series, and that additional sieve sizes would have to be allowed for, the sponsors of the new series nevertheless made an effort to preserve a definite relationship between mesh-number and product-size. In these respects they more than succeeded, for, using wire of standard gauge, the series was extended from 17 sieves to 25, the reduced wire used in their manufacture giving an average screening area of 35 per cent., but in respect of mesh-size the position was improved still further, the sieve-number becoming the reciprocal of the aperture size—that is to say, the 200 screen had apertures of $\frac{1}{200}$ inch. In such a case it may be felt that in discarding both the old and the new I.M.M. series the Institution has lost something in prestige and only gone part of the way towards uniformity.

The results of the adoption of the new B.E.S.A. specification by the Institution are not easy to see, but it is feared that they will not be all that the supporters of this new series hope. The B.E.S.A. specification provides for the manufacture of sieves which are only approximately akin to those of the Tyler series, so widely used abroad, the slight differences being due, of course, to the necessity of using wires of British gauge, although it has been necessary to depart from this in a few instances in order to provide finer differences in aperture than could otherwise have been obtained. It should be realized, therefore, that the new series do not conform exactly to the Tyler scale and may possibly have hard work to compete against the persuasion employed by the selling organizations behind the Tyler series. Be that as it may, the fact remains that the old I.M.M. series has gone, even before members can have had time to reflect on the consequences of such an act, and with it have gone its undoubted advantages. After all, it may justly be said that it matters little that the apertures of a sieve series should advance in a definite ratio of $\sqrt{2}:1$ for consecutive sieves, as such relationships have no significance in the solution of practical problems. However, for the sake of uniformity something must lose its individuality and no doubt we shall in time derive consolation from the fact that in future when one speaks of a 200-mesh sieve it means almost the same as the other fellow's, so that, in bestowing a benediction on the old I.M.M. series, we may at the same time give the new B.E.S.A. series our best wishes and hope that it will prove as successful as its predecessor.

REVIEW OF MINING

Introduction.—The main feature of last month's base-metal markets has been the collapse of copper, which on June 4 reached the lowest price ever recorded, £34 1s. 3d. Although copper has since rallied slightly, the position of all base metals is still weak. Plans for an international conference on silver are still in abeyance, although the United States Government has intimated that it is ready to supply all data to such a conference.

Transvaal.—The output of gold on the Rand for May was 867,949 oz. and in outside districts 42,330 oz., making a total of 910,279 oz., as compared with 882,337 oz. in April. The number of natives employed in the gold mines at the end of the month totalled 207,109, as compared with 206,770 at the end of April.

The accounts of the Central Mining and Investment Corporation for 1930 show a profit of £483,926. The amount brought in from the previous year was £71,890, but, in order to provide for depreciation in the market value of securities, it was necessary to transfer £310,000 from reserve, the total sum available being £865,816. Of this amount £75,000 was provided for income tax, £763,549 for depreciation, and the balance of £27,267 was carried forward. In addition to the above allowance for depreciation it has been found necessary to transfer £1,040,000 from the reserve fund to a " depreciation reserve account " in order to make provision against the corporation's interest in the Anglo-Spanish Construction Company.

During 1930 the Anglo American Corporation of South Africa made a profit of £340,393, to which must be added the balance of £509,248 unappropriated at the end of the previous year. To meet the position created by heavy depreciation in securities and diamond interests, however, it was necessary to transfer £750,000 from the reserve fund, £250,000 from the special fund for stabilization of diamond interests, and £65,000 from the reserve for government taxation. Of the total amount of £1,914,641 thus made available £1,091,499 was written off the value of shares and investments, £450,000 was required to meet the ordinary dividend of 22½% declared in February, 1930, £120,000 was absorbed in the payment of dividends on preferred stock, and, after making various other allowances, the balance of £204,884 was carried forward.

The report for 1930 of the African and European Investment Company, which has recently concluded an agreement with the Union Corporation for the development of Grootvlei, shows a profit of £100,382, a decrease of £24,387 when compared with the previous year. With the amount brought in there was an available total of £179,114, of which £60,000 was appropriated to reserve, the balance being carried forward.

At a special meeting of the New Kleinfontein Company held last month it was resolved that a new board of directors should be appointed, due to the feeling aroused by the action of the old board in disposing of 59 claims to the New Modder. Mr. G. Mackenzie, who presided at the annual meeting held in Johannesburg this month, stated that the new board had been able to effect certain economies and that instructions had been given for proceeding with the development of the Apex section of the mine.

Development work at the Daggafontein Mines adjacent to the Springs Mines boundary continues and conditions appear to be similar to those at Springs with regard to direction and continuity of ore-shoots, width of reef, and pay percentage. Recent disclosures on the Kimberley reef have been interesting, but it is impossible to allow work on this reef without impeding shaft-sinking. At the annual meeting in Johannesburg last month it was stated that the shaft had reached a depth of 3,283 ft. and it was expected that the reef would be struck at a depth of 3,850 ft. probably late in July.

In accordance with the policy of consolidating the position of the Rand Selection Corporation, outlined at the annual meeting held in February last, the board has announced the sale of 100,000 of the reserve shares at 9s. each—representing a premium of 4s. per share—subject to certain calls on the remaining reserve shares.

Diamonds.—Towards the end of last month the Minister of Mines in the Union Government outlined the main items of the new agreement between the government and the chief producers. The quotas have been fixed as follows :—De Beers, 54·4% ; Premier Diamond, 10·6% ; New Jagersfontein, 10% ; Consolidated Diamond Mines of South-West Africa, 25%. The Union Government has accepted a quota of £1,500,000, the other producers being allowed £8,000,000, subject to a minimum sale of £375,000 each half-

year to South African cutters. In view of the refusal of South Africa to restrict production, the International Diamond Commission decided to abolish the limitation of production which has been in existence since January last and ordered a general resumption of work, but the reported intention of the Union Government to summon an international conference has been welcomed by the Association of Master Cutters, who are anxious to reach agreement on the question of production limitation.

Southern Rhodesia.—The output of gold from Southern Rhodesia during April was 43,776 oz., as compared with 42,278 oz. for the previous month and 45,806 oz. for April, 1930. Other outputs for April were: Silver, 5,862 oz.; copper, 84 tons; coal, 53,456 tons; chrome ore, 9,897 tons; asbestos, 2,976 tons; mica, 3 tons.

Northern Rhodesia.—The report of the Rhodesia-Katanga company for 1930 shows that since the issue of the progress report for January last work on the Kansanshi property has been confined to the sinking of two main shafts, diamond drilling, and the detailed examination of suitable sites for the reduction plant. At the end of April the south main shaft had been sunk to 543 ft. and timbered to 500 ft., while the north shaft had reached 288 ft., having been timbered to 265 ft. The report of Mr. Wheeler, the consulting metallurgist, gives the results of numerous tests on Kansanshi ores which show that they are amenable to simple treatment with good recovery and a site has been chosen for the reduction plant. Work done to date is stated to show that ore extends into the surrounding area held by the Rhokana Corporation and there has been an interchange of technical information between the two companies with the object of investigating the extension of the ore-bodies, it being felt that such work would have a considerable bearing on the question of railway connexions.

The report of Mufulira Copper Mines for the period from the date of incorporation—February 3, 1930—to December 31 last states that the ore reserves on the company's Mufulira, Chambishi, and Baluba properties at April 20, 1931, were estimated to be 162,000,000 short tons, averaging 4·14% copper, of which 96% is in the form of sulphide. Development at the Mufulira and Chambishi properties was continued throughout the period under review and the first unit of plant at Mufulira to treat 1,500 tons a day of the higher grade ores from Mufulira and Chambishi is now in course of erection. It will be recalled that the capital of the company was increased to £900,000 at the end of 1930 and the entire share capital is now held by the Rhodesian Selection Trust, Ltd., Rhokana Corporation, Ltd., and the British South Africa Company, who are between them meeting all financial requirements.

In a progress report for the March quarter shareholders of Rhokana Corporation have been informed that it is anticipated that the concentrator at the N'Kana mine will begin operations about the end of the year and that the smelter will be ready shortly afterwards. During the quarter under review 19,857 tons of ore from the N'Kana mine, averaging 2·61% copper, was treated in the pilot mill, 846 tons of concentrates averaging 52% copper being recovered. Experiments were continued to determine the most efficient methods of treatment.

Shareholders of Roan Antelope Copper Mines in a progress report for the three months ended March 31 were informed that development of the mine and installation of working gear were proceeding rapidly, the Beatty Shaft headgear being completed and the cage in service. It was expected that production of concentrates would commence about the end of the present month, the mill operating at reduced capacity, and that concentrates would be shipped until the smelter had been completed. A cabled message issued at the beginning of June stated that ore hoisting was started from the Beatty Shaft on May 21 and that on May 31 the first unit of the mill was operating at full capacity and giving satisfactory results.

Nigeria.—While it has been found possible to pay shareholders of Kaduna Syndicate a dividend of 7½%, making 10% for the year, the directors of Kaduna Prospectors have decided not to recommend a distribution for the year ended October 31 last.

Australia.—Shareholders of the Zinc Corporation have been informed that after making provision to meet the fall in value of stocks of metal and concentrates on hand at December 31 last it has been impossible to declare a final dividend in respect of 1930. The continued low prices of lead and zinc have also forced the North Broken Hill to pass the dividend usually declared for the June quarter.

An accident to the main shaft winding engine and gear at the South Kalgurli Consolidated which took place at the

beginning of the month was thought likely to stop mining and treatment operations for at least a week.

India.—During 1930 the mine of the Indian Copper Corporation produced 135,616 short wet tons of ore, against the 80,151 short tons mined in 1929. Development during the year was kept at a minimum and consequently the reserves show a reduction from 797,741 tons, averaging 3·32% copper, to 697,146 tons, averaging 3·21% copper. The output from the refinery, where two new 8-ft. Great Falls-type converters have now been installed, was 2,974 long tons. At the rolling-mill, where regular production was commenced in August last, 718 tons of yellow-metal sheet was produced up to the end of the year. The year's working resulted in a profit of £47,391 and, with the balance of £9,760 brought in, there was an available total of £57,151. Interest on debentures absorbed £21,391 and, after making allowances for mining expenses, depreciation, etc., the balance of £6,401 was carried forward.

A serious fire occurred at the Nundydroog mine on May 24, breaking out in a stope at the 4,200 ft. level and resulting in serious casualties. The fire was nearly extinguished by the end of May and will doubtless affect the output for the current month.

Burma.—The directors of Burma Corporation have issued a statement to the effect that owing to the unprecedented fall in metal prices payment of any further dividend for the current year would not be justified.

Malaya.—The report of Idris Hydraulic Tin for 1930 shows the output of tin concentrates to have been 353 tons, as compared with 450 tons in 1929. The amount realized from the sale of tin ore during the year was £28,281, representing an average price of £80 1s. 8d. per ton, as compared with £114 6s. 6d. for the previous year. The profit for the year, after making provision for depreciation, etc., was £7,431, which, with the balance of £16,149 brought in from the previous year, made an available total of £23,580. A dividend equal to 2½%, paid in March, 1930, absorbed £3,000 and £5,306 was written off investments, leaving £15,274 to be carried forward.

In a circular to shareholders of Sione Tin (F.M.S.) it is stated that, in view of the continued fall in tin prices, it has been decided not to recommence dredging operations on June 1, but to place the dredge on a care-and-maintenance basis until conditions improve.

China.—A circular issued last month to shareholders of Chinese Engineering and Mining stated that the sales of coal during the first six months of the current year show an increase on those of last year, but that a dispute which arose with the Peiping-Liaoning Railway was severely restricting the transport of coal from the mines. This state of affairs has compelled the directors to postpone the consideration of any dividend payment. Later advice from China states that the dispute has now been settled on the Kailan Mining Administration agreeing to pay $1,200 (Mexican) in settlement of the railway's claim for demurrage.

Mexico.—Towards the end of last month the Santa Gertrudis Company was informed that the main pumping station on the 19th level of Dos Carlos mine had been put out of action by a fire, which also resulted in loss of life. The water was quickly under control, but it was estimated that production was held up for about ten days.

Spain.—Shareholders of San Finx Tin Mines have been informed that sales of concentrates during 1930 realized £33,600, mine expenses amounting to £32,000. In order to meet tax liabilities and other expenses and to provide additional working capital it has been decided to issue £15,000 in 8% debentures, the issue being made at £75 per £100 debenture.

Yugoslavia.—The report of Trepca Mines, Ltd., for the three months ended March 31 last shows that the mill was treating an average of 699 tons daily over the period stated, the lead recovery amounting to 95·6% and that of zinc to 83·7%. The revenue for the three months was estimated to be £88,987 and the working profit £31,031, while capital expenditure amounted to £12,407.

Tin.—The International Tin Committee, which met at The Hague last month, proposed a further reduction in the output of the countries participating in the restriction scheme of not less than 20,000 tons a year. The four governments concerned decided to accept the new quotas, which now become as from June 1 : Bolivia, 28,818 tons ; Malaya, 45,355 tons ; Dutch East Indies, 25,159 tons ; Nigeria, 6,513 tons. The announcement of the cut caused a rally in the price of the metal, but this subsequently declined in view of a further increase in stocks.

ORE RESERVE CALCULATIONS AT THE BAWDWIN MINE

By ALLAN B. COLQUHOUN, E.M.

In this article the author, after dealing particularly with the Bawdwin mine, reviews the general principles of estimating ore reserves and mine yield.

The Bawdwin mine of the Burma Corporation is situated in the Northern Shan States, a federation of semi-independent native states in the northern part of Burma, and lies in E. Longitude 97° 20′ and N. Latitude 23° 6′. Its early history dates back to the 14th century, from which time it was operated by the Chinese until 1868. Europeans became interested in 1900 and, after a large amount of discouraging work, opened up the Chinaman lode, one of the largest high-grade silver-lead-zinc ore-bodies in the world.

GEOLOGY.—The ore-bodies are found in a narrow band of ancient rhyolite, or rhyolitic tuff, striking roughly N.W. and S.E. The series is probably early Ordovician or Cambrian, and is overlaid conformably by a series of non-fossiliferous shales and sandstones of Ordovician or Silurian age and finally by the Devonian Plateau limestone. Beneath the rhyolite series are the oldest sedimentary rocks in the district (slaty shales, phyllites and greywackes) and beneath these in turn is the granite. The entire series has been tilted up at a high angle, the up-turned edges becoming a land surface on which recent sedimentary beds have been unconformably deposited. The erosion of these beds has exposed the rhyolite for a distance of three miles and also, in one or two places, the outcrop of the ore-body contained therein.

Ore-body.—The ore-body is well defined and is about 3,000 ft. long, but it is divided by the Yunnan and Hsenwi faults into three separate parts of about equal lengths, locally known as the Chinaman, Shan, and Meingtha lodes, after the indigenous races who work in the mine.

The Chinaman is the central or main ore-body, averaging in width 50 ft., with a maximum of 140 ft., of solid lead-zinc sulphides. The Shan is the northern portion, which has been cut off from the Chinaman and thrown 700 ft. in a north-easterly direction. It is about 20 ft. in average width and contains high-grade copper in addition to lead-zinc sulphides. The Meingtha is the most southerly portion and it has just recently been opened up on No. 2 level. It has been moved 1,200 ft. in a south-easterly direction by the Hsenwi fault and will probably average in width about the same as the Shan. No stoping has been done on the Meingtha ore-body, as it is not sufficiently developed.

The major axis of the entire ore-body has a general pitch to the north. In the Chinaman and Shan lodes, the dip is to the west, although in the lower levels it appears to be turning over, whereas in the Meingtha the dip is to the east. The hanging-wall is quite regular, but the foot is ill-defined, as the ore channel is wide and composed of a series of parallel fissures. Most of these fissures join the main hanging-wall fissure in depth and what were thought to be parallel lodes in the early days proved to be only branch veins. The extreme hanging-wall, in general, forms a well defined boundary for the ore. At this plane there is solid high-grade lead-zinc ore which gradually decreases in value towards the footwall until it becomes of low grade and finally merges into mineralized rock. There is actually no stoping limit towards the footwall, the latter operation being arbitrarily controlled from time to time by what is considered commercial ore. Up to recent years no rock under 20% combined lead and zinc sulphides with accompanying silver was considered profitable ore, but during the last two years this has been lowered to 16%. The total ore as developed and extracted in the entire ore-body to date is as follows :—

	Tons.	*Ag. Oz.*	*Pb. %*	*Zn. %*	*Cu. %*
Developed . .	7,881,768	21·4	25·1	15·2	0·96
Extracted . .	3,616,103	22·6	24·7	15·0	1·05
Total ore reserve in Mine . .	4,265,665	20·4	25·5	15·3	0·88

EXPLORATION.—Exploration and development work is done by means of shafts, drives, cross-cuts, and winzes. On account of the great friability and high specific gravity of the ore and the numerous vugs in the ore-body itself, diamond drilling was abandoned in the early days of development as unreliable. The drives are generally made in the footwall and cross-cuts are driven at intervals of 100 ft. to cut the ore-

body. Levels are generally at 130 ft. intervals with rises at every cross-cut.

Sampling.—Each cross-cut is sampled at intervals of 5 ft., on both sides, whether ore or waste. Sections showing commercial ore are re-sampled and the averages taken for calculation.

Drives and rises are sampled similarly, but their values are not included in the ore-reserve, calculations being used only to prove the continuity of ore and grade. The ore is either an intimate mixture of lead and zinc sulphides, a mixture of lead, zinc, and copper sulphides with the latter sulphide in the form of chalcopyrite in separate bands, or bodies of pure chalcopyrite only. As most of the ore is soft and friable, grooved samples are easily cut by hammer and moil. The results of all samples, the ore being checked and if necessary rechecked, are entered in an assay ledger, one page for each cross-cut, drive or rise. The use of a width factor of one for every 5 ft. sample, with progressive totals of width factor times Oz. Ag., % lead, % zinc, and % copper, facilitates the averaging of the various parts of the cross-cut which assay commercial ore.

All stopes are sampled daily, and every set of ground taken out is plotted on the stope plans and the values entered thereon. There is a separate plan for each floor of a stope or series of stopes.

All samples are entered on assay plans—scale 40 ft. to 1 in.—and in addition, all commercial ore is shown on special ore

TABLE 1

ORE RESERVE CALCULATIONS—JANUARY 1, 1925

No. 7 Level—Chinaman Lode

Cross-cuts.	Area.	Silver. Ozs. p. ton.	Silver. Oz. ft.	Lead. %	Lead. % feet.	Zinc. %	Zinc. % feet.	Copper. %	Copper. % feet.
W. X. 767	2669	21·4	57116·6	27·7	72329·9	14·7	39234·3	nil	
W. X. 847	5349	15·3	81839·7	25·8	138004·2	7·2	38512·8	Tr.	
W. X. 927	5897	34·3	202267·1	39·6	233521·2	11·9	70174·3	nil	
W. X. 1027	7630	24·0	183120·0	27·5	209825·0	7·2	54936·0	nil	
W. X. 1137	7379	24·4	180047·6	33·6	247934·0	11·3	83382·7	0·3	1301·4
W. X. 1207	5927	13·8	81792·6	20·7	122688·0	13·8	81792·6	nil	
W. X. 1287	5302	16·9	91124·8	20·9	112692·8	12·6	67939·2	0·5	2696·0
W. X. 1387. $\frac{79 \times 37·5}{2} + \frac{79 \times 38}{2} + \frac{77·5 \times 43·5}{2} + \frac{77·5 \times 35}{2}$	6024	15·4	92769·6	23·5	141564·0	7·2	43372·8	2·8	16867·2
W. X. 1497. $\frac{70 \times 39}{2} + \frac{70 \times 29·5}{2} + \frac{51 \times 36·5}{2} + \frac{51 \times 26·5}{2}$	4004	7·4	29629·6	12·7	50850·8	9·0	39239·2	1·3	5205·2
W. X. 1587. $\frac{49·5 \times 27·5}{2} + \frac{49·5 \times 17·5}{2} + \frac{16 \times 19·5}{2} + \frac{19·5 \times 22}{2}$	1484	8·0	11872·0	1·2	1780·8	0·4	593·6	4·2	6232·8
Total	51755	19·54	1011579·6	25·72	1331191·6	10·03	519177·5	0·6	32302·6

Wt./cu. ft.

Pb.	= PbS.	PbS.	
25·72 × 1·16	= 29·835 ÷	468	= 0·06375 Cu. Ft. per 100 lbs.
Zn.	= ZnS.	ZnS.	
10·03 × 1·49	= 14·945 ÷	250	= 0·05978 ,, ,,
Cu.	= $CuFeS_2$	$CuFeS_2$	
0·79 × 2·9	= 2·291 ÷	262	= 0·00874 ,, ,,
	Quartz		
Rock	52·929 ÷	165	= 0·32078 ,, ,,
	100·000		0·45305 ,, ,,
5% voids	0·45305 ÷	95	= 0·47690
	0·47690 × 2240		= 10·68 Cu. Ft. Per Ton.
	$\frac{51755}{10·68}$		= 4864 Tons Feet.

TABLE 2

SUMMARY OF ORE RESERVE CALCULATIONS—JANUARY 1, 1925

Chinaman Lode.

Level.	Feet. Up.	Feet. Down	Feet. Total.	Tons feet.	Total tons.	Silver. Ozs. p. ton	Silver. Ounces.	Lead. %	Lead. Tons.	Zinc. %	Zinc. Tons.	Copper. %	Copper. Tons.
No. 7—Proved	66·7	25·0	91·7	4846	444378	19·5	8665371	25·7	114205·2	10·0	44437·8	0·8	3555·0
Probable Ore below No. 7 Level		25 to 100	75	4846	363450	19·5	7087275	25·7	93406·7	10·0	36345·0	0·8	2907·6

reserve plans of the same scale, with the average width and grade of each cross-cut marked in the margin.

Estimating.—After two or three levels had been developed, by cross-cuts and rises through the ore, it was apparent that the ore-body was uniform in size and grade from level to level and cross-cut to cross-cut and that the continuity of the ore and transition of values from high to lower grade was so gradual, that it was possible to estimate the ore-body on the cross-cuts alone. This simplifies the estimate, as the summation of the widths and assays of the ore in the various cross-cuts, modified by deduction from geological data wherever necessary, gives the area and grade of that level. This area and grade multiplied by distance between levels (half up and half down) gives the volume and tons of metals.

Ore estimates are made semi-annually and are divided into two classes—proved and probable ore. Possible ore is not considered, as its inclusion would destroy the accuracy of the ore estimate. Proved ore is that rock actually proved in three dimensions (width, length, and height) with an arbitrary vertical distance of 25 ft. taken below the lowest level, or 50 ft. beyond the last cross-cut. Probable ore is that rock 25 to 100 ft. and in some cases 25 to 65·5 ft. (half way to next level) below the lowest level following the general outline of the proved ore above or modified to meet any geological changes apparent. It very seldom amounts to more than 5% of the

TABLE 3.

Comparison of the Total Ore Extracted in Two Almost Completed Sections as per the Original Ore Estimates, January 1, 1930.

Chinaman Section (above No. 6 Level and North of Winze 1135).

	Tons.	Pb. %	Zn. %	Cu. %
Total extraction as calculated from stope plans for section	1,201,943	27·8	13·5	1·3
Adjusted by correlation factors	1,281,271	25·9	13·5	1·21
Ore reserve estimate for same section	1,256,730	26·3	14·2	1·26
Estimate of small quantity of ore still unextracted	107,518	20·8	10·1	1·4
Ore reserve estimate of section mined	1,149,212	26·8	14·6	1·25
Extracted (from above adjusted figures)	1,281,271	25·9	13·5	1·21
Difference	+ 132,059	— 0·9	— 1·1	— 0·04

		Lead.		Zinc.		Copper.
Tons.	%	Tons.	%	Tons.	%	Tons.
1,149,212	26·8	307,989	14·6	167,785	1·25	14,365
1,281,271	25·9	331,849	13·5	172,972	1·21	15,503
+ 132,059		+ 23,860		+ 5,187		+ 1,138
+ 11·49%		+ 7·75%		+ 3·09%		+ 7·92

Actual recovery (tonnage of ore) . . 111·49%
,, ,, (,, ,, metals) . . 106·16%

Shan Section (above No. 6 Level).

	Tons.	Pb. %	Zn. %	Cu. %
Total extraction as calculated from stope plans for section	503,870	15·2	9·5	3·3
Adjusted by correlation factors	537,125	14·2	9·5	3·1
Ore reserve estimate for same section	601,741	16·0	9·8	5·6
Estimate of small quantity of ore still unextracted	117,344	13·2	7·6	6·9
Ore reserve estimate of section mined	484,397	16·7	10·3	5·3
Extracted (from above adjusted figures)	537,125	14·2	9·5	3·1
Difference	+ 52,728	— 2·5	— 0·8	— 2·2

		Lead.		Zinc.		Copper.
Tons.	%	Tons.	%	Tons.	%	Tons.
484,397	16·7	80,894	10·3	49,893	5·3	25,673
537,125	14·2	76,272	9·5	51,027	3·1	16,651
+ 52,728		— 4,622		+ 1,134		— 9,022
+ 10·89%		— 5·71%		+ 2·27%		— 35·14

Actual recovery (tonnage of ore) . . 110·89%
,, ,, (,, ,, metals) . . 92·00%

Actual recovery (tonnage of ore)—both sections . 111·31%
,, ,, (,, ,, metals)—both sections . 102·64%

proved. Tables 1 and 2 give some ore reserve calculations for the Chinaman lode.

The actual ore reserve at any time is found by deduction : the total ore developed less the total ore extracted. The accuracy of this figure depends on two factors, the accuracy of the original estimate and the value of the extracted ore, and it is therefore necessary to know the combined value of these two factors before the reserve can be accepted or modified.

Calculations for Actual Recovery (determination of correlation factor).—As the ore from all parts of the mine is mixed together in chutes and pockets and trammed out of a common adit, there is no means of obtaining a record of the actual quantity and grade from any particular place, except by stope measurements and samples, which must be correlated to agree with weigh-bridge returns and subsequent accurate sampling.

	Tons.	*Pb. %*	*Zn. %*	*Cu. %*
Total extraction for the whole mine as per smelter and mill weigh-bridge and Samples Returns to January 1, 1930 . .	3,343,554	25·0	15·3	1·02
Total extraction for the whole mine as calculated from stope plans to January 1, 1930 . .	3,136,684	26·8	15·3	1·10
	+ 206,870	— 1·8	0·0	— 0·08
Factors for adjustment .	1·0660	0·9328	1·00	0·9273
Percentage difference .	6·60	— 6·72	0·00	— 7·27

There are two sections of the mine which have been almost completely mined out and it is from these sections that the first

TABLE 4.

MINE EXTRACTION CALCULATIONS—JANUARY 1, 1931.

COMPARISON OF THE TOTAL ORE EXTRACTED IN TWO ALMOST COMPLETED SECTIONS AS PER THE ORIGINAL ORE ESTIMATES.

Chinaman Lode (above No. 6 Level and North of Winze 1,135).

	Tons.	Pb. %	Zn. %	Cu. %
Total extraction as calculated from stope plans for section	1,275,186	26·9	13·4	1·36
Adjusted by correlation factors	1,350,167	25·8	13·4	1·28
Ore reserve estimate for same section	1,256,730	26·3	14·2	1·26
Estimate of small quantity of ore still unextracted . .	94,195	21·5	12·5	1·5
Ore reserve estimate of section mined	1,162,535	26·7	14·3	1·24
Extracted (from above adjusted figures) . . .	1,350,167	25·8	13·4	1·28
Difference	187,632	— 0·9	— 0·9	0·04

	Lead.		Zinc.		Copper.	
	%	Tons.	%	Tons.	%	Tons.
1,162,535	26·7	310,397	14·3	166,242	1·24	14,415
1,350,167	25·8	348,343	13·4	180,922	1·28	17,282
+ 187,632		+ 37,946		+ 14,680		+ 2,867
+ 16·14%		+ 12·22%		+ 8·83%		+ 19·89%

Actual recovery (tonnage of ore) . . . 116·14%
" " (" " metals) . . 111·30%

Shan Lode (above No. 6 Level).

	Tons.	Pb. %	Zn. %	Cu. %
Total Extraction as calculated from stope plans for section	592,449	14·5	9·1	3·29
Adjusted by correlation factors	627,285	13·9	9·1	3·09
Ore reserve estimate for same section	601,741	16·0	9·8	5·6
Estimate of small quantity of ore still unextracted . .	88,507	12·4	7·6	6·9
Ore reserve estimate of section mined	513,234	16·6	10·2	5·4
Extracted (from above adjusted figures) . . .	627,285	13·9	9·1	3·09
Difference	114,051	— 2·7	— 1·1	— 2·31

	Lead.		Zinc.		Copper.	
Tons.	%	Tons.	%	Tons.	%	Tons.
513,234	16·6	85,197	10·2	52,350	5·4	27,715
627,285	13·9	87,193	9·1	57,083	3·09	19,383
+ 114,051		+ 1,996		+ 4,733		— 8,332
+ 22·22%		+ 2·34%		+ 9·04%		— 30·06%

Actual recovery (tonnage of ore) . . 122·22%
" " (" " metals) . . 99·03%

Actual recovery (tonnage of ore)—both sections . . . 118·00%
" " (" " metals)—both sections . . . 108·17%

reliable figures for the ultimate yield of the mine as a whole are obtained. The first section is that portion of the Chinaman lode lying between the surface and No. 6 level and between co-ordinate 1135 South and the Yunnan fault. The second section is all the Shan lode lying between the surface and No. 6 level.

The accompanying statement in Tables 3, 4, and 5, shows that in mining the wide Chinaman ore-body with an indefinite low grade footwall, a larger gross tonnage is obtained at a slightly lower grade, but still containing a larger amount of metals, owing, no doubt, to mining some grades of ore below that originally taken into the ore estimate as commercial ore.

In the Shan ore-body the conditions are different. The copper, a very friable chalcopyrite, is mixed with the other sulphides of lead and zinc in a comparatively narrow vein with a fairly definite footwall; the latter containing no or very little values. It may be that there is an error in sampling due to the greater friability of the chalcopyrite when mixed with lead and zinc sulphides, owing to a larger proportion of the former being included in the sample.

TABLE 5.

MINE EXTRACTION CALCULATIONS.—JANUARY, 1931.

Adjustment of the calculation of ore mined from Stope Plans and Samples to actual Weigh-Bridge returns, with corresponding Mill and Smelter Assays.

	Tons.	Pb. %	Zn. %	Cu. %
Total extraction for Mine as calculated from Stope Plans (to Jan. 1, 1931)	3,658,286	25·6	14·8	1·15
Total extraction for Mine as per Mill and Smelter Assays plus Dump (for same period)	3,873,368	24·6	14·8	1·08
Difference	+ 215,082	— 1·0	0·0 —	0·07
Factors for adjustment	1·0589	0·9609	1·0	0·9391
Percentage difference	+ 5·88%	—3·91%	0·0 —	6·09%

(To be concluded.)

DIAMOND RECOVERY FROM GRAVELS AND CLAYS IN GOLD COAST COLONY

By EDWIN D. CANDLISH, A.M.I.M.E.

The author describes the methods employed in the mining and extraction of diamonds in Gold Coast Colony.

The diamond is found over a wide area in Gold Coast Colony, where it occurs in the gravels and clays of streams and also in old marine deposits. In the Birrim Valley it is found in quantities warranting economic working. The first discovery of these stones was made in 1919 by the Geological Survey at Abomoso in Akim Abuakwa [1] and in subsequent prospecting operations an area of fifty square miles was found to be diamondiferous (Fig. 1). Diamonds have been found at points 80 miles north-east, 130 miles north-west and 120 miles south-west of Abomoso.

The stones found are small, but in general are of good quality. A very large number are between 0·1 and 0·5 carat in weight; although the largest stone found in the Colony weighed 9 carats, but was not of good quality.

There is no evidence that the diamonds have any direct association with volcanic plugs—it is also a matter for conjecture whether they have been formed by the action of pegmatite intrusions on highly carbonaceous slates, phyllites, or graphite schists. The geological structure of the country is only partially known. Wide areas have been subjected to marine erosion and denudation and there has been much deposition which masks many of the older rocks. A fuller account of the mode of occurrence of the diamond in this colony was given in an article by S. V. Griffith which appeared in the MAGAZINE for November, 1929.

PROSPECTING.—As great areas in Gold Coast Colony are covered with primeval forest, prospecting is naturally a slow process. The general procedure is to clear the bush in narrow lanes or lines along which it is desired to pit. These lines are usually cut across river flats and swamps roughly at right angles to the flow of the stream. An accepted practice is to cut lines at 100 ft. intervals, but this distance can be varied at the dictate of circumstance. Prospecting pits 4 ft. by 2 ft. 6 in. are put down at 100 ft. distances along the lines and in certain conditions, when it is desired to delimit the pay streak, "split pits" may be put down—that is to say, pits may be sunk at lesser intervals than 100 feet.

In sinking a pit, overburden is excavated until wash is disclosed, it often being advisable to test apparent overburden immediately overlying this. It is also a safe rule to wash bedrock in some cases to make

[1] A. E. Kitson, *Geol. Surv. Gold Coast*, 1919.

sure that values do not persist. All wash removed from pits must be measured on an *in situ* basis and frequently boxes are employed so that wash can be measured in the loose. When the ground does not stand up or where pits are waterlogged, care must be taken to ensure that bed rock is cleaned up completely. All large boulders should be carefully washed as diamond-bearing gravel may adhere to them. In prospecting for diamonds it is advisable to book the number of stones recovered from each pit so that a fair reflex of values may be arrived at. In cases of doubt, where values are very high, or very low, and against the run of the general pay streak figures, a check pit is always justified. In systematizing this work the following data is always necessary: (1) Number and bearing of line referred to a beacon or other landmark; (2) number of pit; (3) depth of overburden; (4) depth of wash; (5) nature of wash; (6) nature of bedrock; (7) number of diamonds recovered (outstanding ones being specially noted); (8) recovery in carats per cubic yard of wash excavated.

When the above data has been accurately determined in relation to an area in prospect, a reliable plan of values can be constructed and a general report made to headquarters.

Prospecting during the "greater rains", which are usually experienced from March till July, is not advisable, as then the alluvial flats are waterlogged and the accuracy which is desirable in work of this nature is difficult of attainment.

Rockers.—When wash is extracted from a prospecting pit it is carried in headpans to a point, usually on the bank of a stream, where, after being measured in a box of known capacity, it is washed in rockers by boys specially trained for the task. The rocker [1] (Fig. 2) resembles an old-fashioned cradle and consists of:—

(1) A top sieve of $\frac{1}{2}$ in. mesh;
(2) An intermediate sieve of $\frac{1}{16}$ in. mesh;
(3) The rocker proper which is constructed of wood mounted on rockers, the latter being, in general, shed with hoop iron.

The rocker compartment is screened on sides and bottom, the screening being of fine sand mesh. The first two sieves are removable and are fitted with handles to facilitate this. The rocker is set on hollowed logs which prevent it from becoming bogged. A size of rocker in general use is 4 ft. 6 in. long by about 2 ft. 6 in. in height overall.

[1] A. Livingstone Oke, *Trans.* Inst. Min. and Met., 1925.

FIG. 1.—SKETCH-MAP OF THE GOLD COAST COLONY. THE SHADED AREA SHOWS THE PRINCIPAL KNOWN DIAMONDIFEROUS AREA.

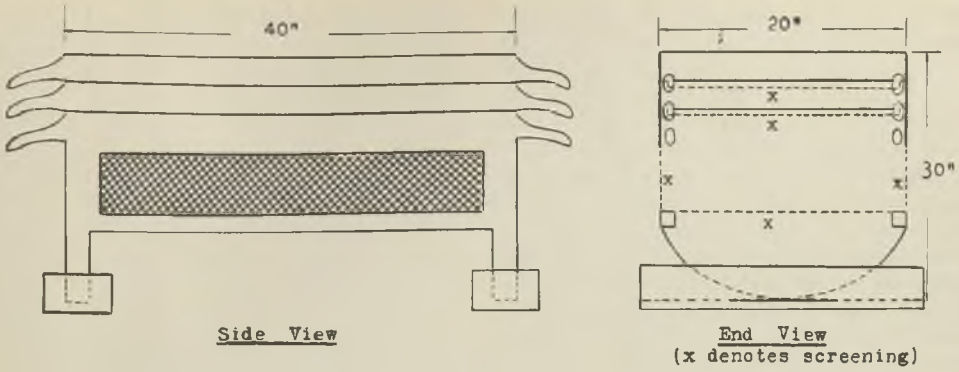


FIG. 2.—GRAVEL WASHING ROCKER USED IN PROSPECTING.

The operation of washing and sizing gravel by the rocker is simple. Two boys stand on it, one at each end, and they impart a jerking sidewise motion to it by the movement of their legs. While this is proceeding wash is fed on to the top sieve by another boy, whilst a fourth pours on water in a fairly steady stream. The latter boy generally stands in the stream where a plentiful supply of water is at hand. When the rocker is fairly full of wash the boy feeding wash stops, but otherwise the cycle of operations persists until all compartments of the rocker contain clean sized gravel which is next removed by sizes for concentration. In prospecting one is well advised to make sure that gravel from different pits is kept separate, otherwise the work is of no value.

Hand Jig.—The hand jig is a rudely-constructed device and a type generally used (Fig. 3) consists of four main parts: (1) Jigging compartment fitted with sand screening; (2) a lever of wood which is forked to give stability; (3) a fulcrum trestle on which the lever pivots; and (4) the trough.

To employ the jig, the compartment is filled to approximately two-thirds of its capacity with the rocker product. The jig compartment is next lowered into the water in the trough and a short sharp jigging motion is imparted to it by means of the lever for some minutes. At the end of this

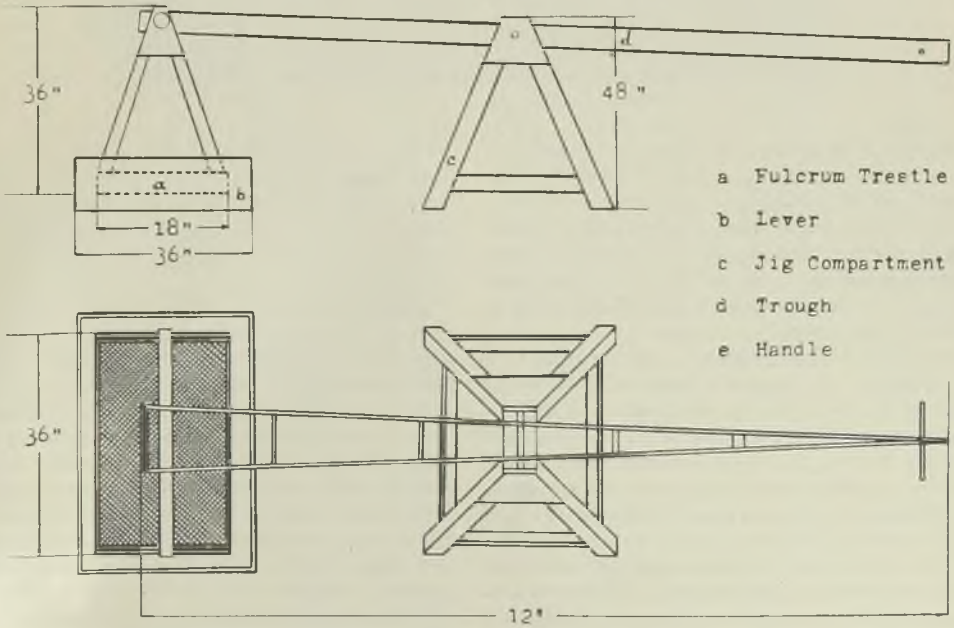


FIG. 3.—HAND-JIG USED IN PROSPECTING.

time the compartment is raised clear of the trough and the top layer on the jig bed, now obviously quartz or material of like specific gravity, is skimmed off the top. Jigging next is resumed and the system of jigging and scraping off tailings alternates until concentrates only are left in the compartment. The jig product is removed when concentration is complete, a wire brush being used to effect the final cleaning of the screen. In this way each size of rocker product is dealt with and all concentrate, which is generally black in colour, is next passed on to native women who sort it, that is, remove the diamonds, if any, by a method to be discussed later. Amount of concentrate is no criterion as to probable diamond recovery as a sparse amount of it may teem with diamonds and again a large amount may be practically barren. Concentrates vary from place to place and may contain any of the following minerals in varying states of division: Gold, pyrite, magnetite, hæmatite, ilmenite, rutile, cassiterite, psilomelane, spinel, quartz, orthoclase, hornblende, muscovite, biotite, kyanite, staurolite, black tourmaline, garnet, augite, actinolite, epidote and zircon.[1]

Paddock Working.—In working diamondiferous ground, the first operation to be considered is the clearing of the bush and as the bush varies in density and character this may be a long operation. In ground where large cotton wood or mahogany trees are to be found the task is much harder than in areas where palms with their comparatively small roots are encountered. The "umbrella" palm generally is an indication that the ground in the vicinity is clayey in character. Among the types of labour for the work of bush clearing the Lagos boy is the best; these people, being thoroughly familiar with the axe and machete, can clear bush at a surprising rate. They are paid a unit sum for each 1,000 sq. ft. cleared as a rule.

Removal of Overburden.—The stripping of overburden in general paddock working must be carried out systematically. Excavation of overburden is performed by contract labour, that is, by boys on task work, their sole tools being the shovel and machete, and, if necessary, the crosscut saw, for the extraction of tree roots of large size. Overburden may vary in thickness from a few inches to ten or twelve feet. The tasks of contract boys are measured out under the supervision of a European and ordinarily a task is approximately 180 cu. ft. in size and for this a fixed rate is paid. Due care must be taken that overburden is stripped completely, as in many places a blue-grey sand devoid of values and of the same colour as the wash is to be found. In order that extraction of gravel may be complete, overburden must be thrown well clear of the excavation; if this rule is not enforced re-handling is inevitable. Where practicable, excavations are carried from the limits of the values and as the deposits are lenticular in section there is a thinning out at these extremities. Large excavations may be divided into two sections, a pump being placed immediately behind the centre point of each. During the rains the ideal method is to strip overburden from the limits of each section to the centre, and in this way water is driven to the centre for pumping. In extracting wash the converse method is resorted to, that is, the wash is extracted from the centre outwards, and thus any water in the excavation gravitates to the bedrock in the centre where it can be pumped out. If an excavation is worked in two sections, stripping of overburden can be carried out in one, while extraction of gravel is proceeding in the other. In paddock working (Fig. 4) the upsteam method is to be preferred as drainage is simplified. In downstream paddock work there is continual trouble due to run-off water from the hillsides inundating the excavations.

The diamondiferous wash is generally blue-grey in colour and may be of any texture from a free gravel to a stiff clay. The latter generally merges into a brown colour. In general the recovery in arenaceous wash is poor. The bedrock varies little in character and is usually a fine texture micaceous clay.

All paddock work is performed under the constant supervision of a native headman who is responsible to the European in charge that the washing plant is kept supplied with with gravel. Paddock workers are divided into two groups, namely, wheelbarrow boys and gravel boys; the former wheel gravel from the excavation up gangways, which are constructed of planks, onto a filling platform where it is tipped into trucks. Gravel boys are subdivided into two groups, namely, digger boys, who dig and stack gravel, and filler boys, who fill it into barrows. All wheelbarrows are constructed of steel.

[1] Raeburn and Milner, "Alluvial Prospecting" (Murby), Chap. VII.

Transport of gravel from the filling platform is by trucks which are of steel and of the side-tipping type. The number of boys employed on tramming is variable and usually has to be augmented from time to time as the tramming distance increases.

DIAMOND RECOVERY PLANT. — The following is a description of a diamond recovery plant, known as No. 2 Atiankama (Fig. 5), which belongs to the West African Diamond Syndicate. It consists of the following units :—

Two 60 ft. belt elevators ;
Two grizzleys with bars 2 in. apart ;
Two puddler boxes ;

It will be seen from the foregoing data that both free gravel and clay can be treated. Both plants can be operated simultaneously, the limiting feature being the capacity of the first treatment washing pan.

Unit Support.—The treatment plant is built up inside a framework of angle iron mainly of L section. The main base channel irons are of U section 10 in. by 4 in. by $\frac{5}{8}$ in. The upright L section angle irons are of $3\frac{1}{2}$ in. by $\frac{1}{2}$ in. section while the bracing angles are of 2 in. by $\frac{3}{8}$ in. section. The plant, comprising washing trommel and pans, is mobile, being mounted on four wheels or rollers.

FIG. 4.—EXTRACTION OF GRAVEL.

One shaking screen $\frac{1}{2}$ in. mesh screening ;
One Washing trommel 14 ft. long with a screened section 4 ft. long fitted with $\frac{5}{8}$ in. mesh screening ;
One 8 ft. diameter first-treatment concentrating pan ;
One 8 ft. diameter second-treatment concentrating pan ;
One sizing trommel fitted with four different sieve apertures, i.e. (1) fine sand screening ; (2) — 2 mm. aperture ; (3) — 4 mm. aperture ; (4) — 7 mm. aperture ;
Two four-compartment jigs of Harz type ;
Two two-compartment jigs of Harz type ;
One 60 b.h.p. engine mounted on road wheels (driving puddler machine) ;
One 45 b.h.p. engine of same type for pan plant ;
One Ruston centrifugal pump capable of throwing 5,000 gall./hour.

Elevators.—Both elevators are of the same type, and are 60 ft. long and mounted on wheels. The width of each belt is 18 in. and is of 5-ply canvas and rubber in the centre, while 3-ply is used for the sides. The angle of elevation of these elevators can be changed by means of pulleys and a gallows which form a permanent part of the structure. The general angle of elevation is about 20° and this should be regarded as a maximum for wet gravel. One elevator feeds the pan plant and the other the puddler machine.

Washing.—The main washing trommel is 16 ft. long overall and is $3\frac{1}{2}$ ft. in diameter. For 10 ft. this trommel is blind and has rake-like projections in this section, past which throughput material must flow. At the discharge end the washing trommel has a 5 ft. section which is fitted with $\frac{5}{8}$ in. mesh

screening. The trommel is set at an inclination of 10° from the horizontal, the slope being in favour of discharge, and runs on rollers which have a face of $3\frac{1}{2}$ in. Thrust rollers are employed as this unit runs in an inclined position. The drive is at the feed end and is through gearing, the whole driving principle being similar to that in the tube-mill. At the discharge end of the trommel a large apron is fitted and into this all material passing through the screen must fall. The apron is so constructed that all matter entering it is led into a launder giving access to the first-treatment washing pan.

Fig. 5.—No. 2 Plant, Atiankama, of the West African Diamond Syndicate, Ltd.

Puddler.—When throughput material is clay some other means than the employment of a washing trommel has to be adopted to effect thorough disintegration. To do this a puddling machine (Fig. 6) is used. The machine consists of two wooden boxes set side by side and identical in every respect. Inside each box is a square section shaft running longitudinally and to this shaft are clamped 40 mild steel beater bars 4 ft. long and 3 in. by $\frac{3}{4}$ in. section. The beater bars are boxed at $1\frac{1}{2}$ in. centres for about 2 ft. of their length so that wear can be taken up. These bars must be readjusted after about every 50 hours running for efficient puddling. All throughput material to the puddler must pass through a bar grizzley with 2 in. spaces. The floor of the puddler box has an inclination of 2 in. in its length and this inclination induces a flow of puddled matter towards the discharge end. As there are two puddler boxes it is possible to clean out and take up the bars in one while the other is in operation.

A shaker screen reciprocating at the rate of 40–50 strokes per minute effects a sizing before gravel passes to the first-treatment washing pan. This screen is so arranged that all material above $\frac{1}{2}$ in. sieve passes over it to oversize tailings; the matter less than $\frac{1}{2}$ in. sieve passes through the screen and so to the first treatment pan.

Concentrators.—The concentrating pans[1] employed are of 8 ft. diameter, the inner rim diameter being 3 ft. The depth of the outer pan rim is 14 in. and the height of the overflow weir or lip is 11 in. The launder from the washing trommel is tangential to the pan circumference and all material entering the pan must pass a bar grizzley with $\frac{1}{2}$ in. spaces. A cast steel spider with eight radial arms is keyed to a vertical driving shaft. On these arms are clamped 40 mild steel tynes or stirrers, 5 to each arm. All the tynes are of wedge-like triangular section $\frac{5}{8}$ in. by $\frac{1}{2}$ in. by $1\frac{1}{2}$ in. except one which is of round section $1\frac{1}{8}$ in. in diameter. This latter is called the stirring tyne and while concentration is in progress describes the largest circle in the pan. The draw-off spigot is on the pan bottom edge and flow

[1] P. A. Wagner, "The Diamond Fields of S. Africa," 1914, p. 206.

of concentrate is controlled by pushing along the extrac or slide also in the pan bottom. The correct speed of rotation of the tynes for efficient concentration is 13½ r.p.m. The floor of the pan and liner plates are constructed of mild steel. The clearance between the tyne ends and pan bottom is determined by the size of sieve on the washing trommel (⅝ in. in this case); ⅞ in. then is allowed to ensure that there is clearance for the largest material which can gain access to the pan. Tynes must always be kept sharp and of correct cross section and to carry this out in practice, one set of tynes (5) is changed every 24 hours. A 6 in. diameter launder from the overflow results. Plungers must be made to fit and yet to work easily so that the jig bed gets a good impulse—plungers which have worn loose allow water to escape with a consequent loss of jigging effect. Jigs treating fines (below 2 mm. sieve) run at 210 s.p.m.; jigs treating 2 mm. to — 4 mm. sieve at 200 s.p.m., while the biggest material, that is, 4 mm. to — 7 mm. sieve is jigged at 180 s.p.m. It is interesting to note that Richards gives speeds of 250, 235 and 175 respectively for the above sieve scales. Water used in jigs can be used over and over again and runs to a sump where it can be pumped up to tanks at the top of the plant for re-circulation.

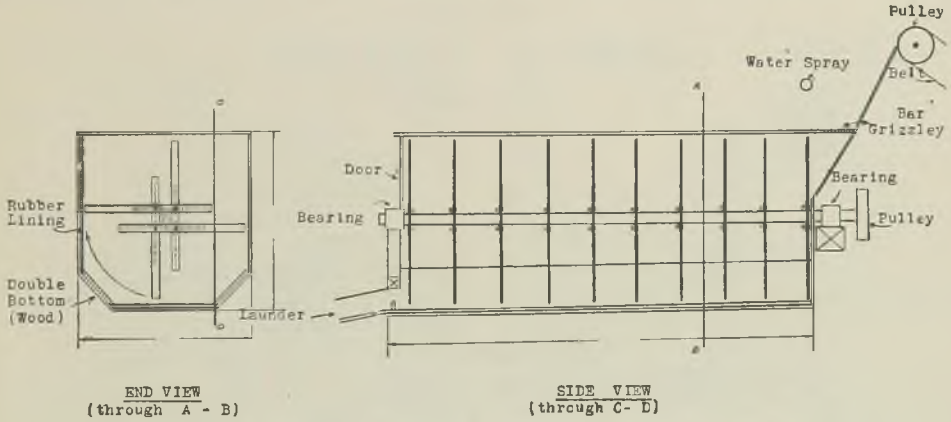


FIG. 6.—PUDDLING MACHINE USED FOR THE DISINTEGRATION OF DIAMONDIFEROUS CLAY.

of the first treatment pan is led to the circumference of the second treatment pan which is a counterpart of the one already described.

Sizing.—The sizing trommel used is 16 ft. in length overall and its outside diameter is 2 ft. The screening fitted to this trommel is of four different meshes as follows: 4 ft. of twill bronze sand screening; 4 ft. of 2 mm. aperture screening; 4 ft. of 4 mm. and 3 ft. of 7 mm. A water jet is used at the feed end and a spray runs the entire length of the trommel which is laid at an angle of 7° to the horizontal.

Jigs.—The plants used at Atiankama are capable of feeding four jigs under ordinary circumstances. Two of these are four-compartment jigs and two two-compartment. The jigs are of the Harz type.[1] Jig screens are constructed of wire-woven brass and are secured to their wooden frames by means of copper tacks which do not readily corrode. Screens must be kept drum tight for best

[1] R. H. Richards, "Ore Dressing" (McGraw-Hill), Vol. I, Chap. XIV, p. 507.

Water Supply.—A Ruston centrifugal pump running at 1,100 r.p.m. pumps circulating water from the settling pool to tanks at the top of the plant. This pump has a capacity of 5,000 gallons per hour. The make-up water amounts to roughly 3,700 gallons/hour. Since installation of the puddler machine it has been necessary to augment this water supply by 50 gallons/min. by using a pulsometer pump taking its steam from the puddler engine.

Power.—The engine driving the pan plant is of 45 b.h.p.; has two cylinders 7½ in. in diameter and operates at 150 lb. pressure per sq. in. The governor used is the Pickering Auto and the driving wheel speed is 165 r.p.m. The engine is mounted on four road wheels to facilitate transport. The fuel burned is wood, mainly African mahogany and odum—200 cu. ft. of this fuel is used per day of 10 hours in this engine.

The engine driving the puddler machine is essentially the same in design, it being of 60 b.h.p.

Treatment of Free Gravel.—The method of treating diamondiferous wash or gravel is not without interest (Fig. 7). The elevator belt carries gravel up to the washing trommel feed chute where it meets a jet of water; the gravel slides into the trommel. Inside this unit the wash tends to slide to the discharge end and in doing so encounters flanged baffles with saw-like edges. Rods arranged in threes hasten the breaking-up of the gravel. At the discharge end of the trommel all material $-\frac{5}{8}$ in. sieve falls through the screened section being sprayed with water the while. At the same time all matter $+\frac{5}{8}$ in. sieve passes over the trommel end into the oversize tailings hopper. All clay balls which survive the washing trommel are recovered and re-treated. Gravel falling through the trommel screen is guided by the trommel apron into a 6 in. launder feeding the first treatment pan with its rotating tynes. Here a sorting goes on by the aid of centrifugal force, the concentrate, that is, diamonds, garnetiferous sand, staurolite, ilmenite, etc., are whirled, by reason of their comparatively high specific gravities, to the circumference of the pan. At the same time lighter matter, such as quartz and more finely divided material, flow over the lip on the inner rim of the pan and so by way of a 6 in. launder to the second treatment pan. The native in charge of the first treatment

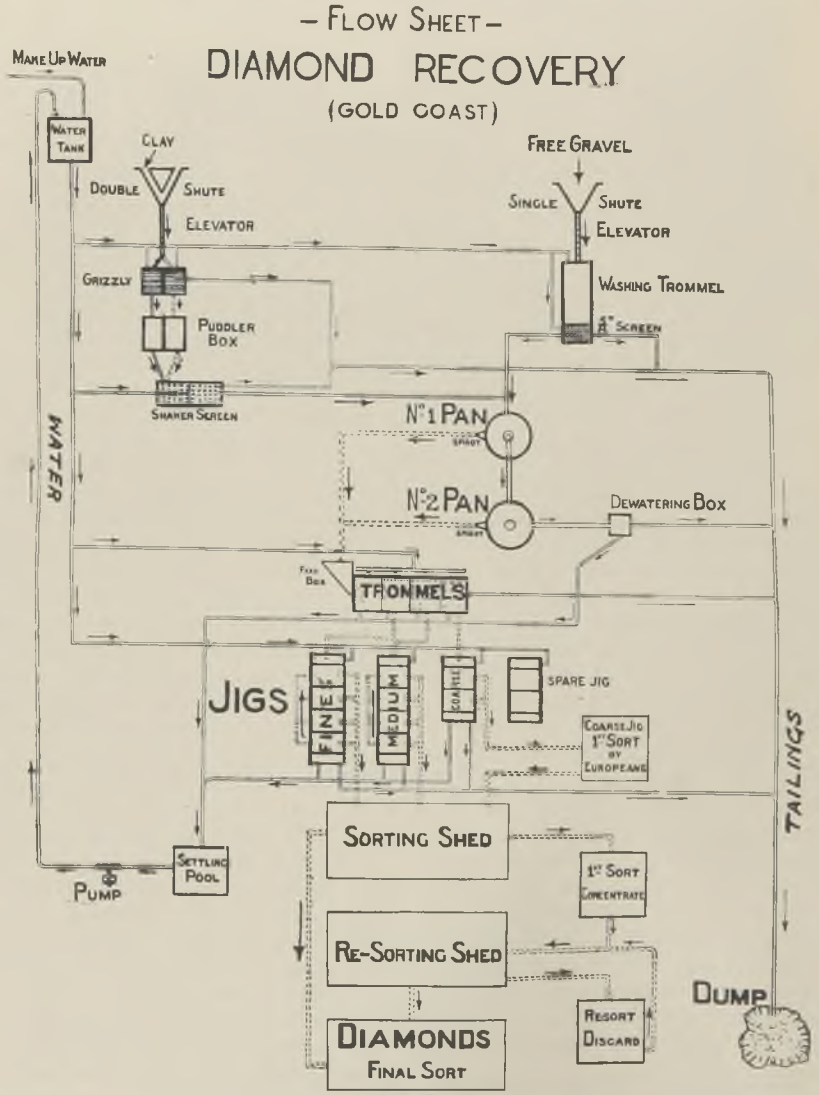


Fig. 7.

pan, by watching the stirring or round tyne, knows when to draw off concentrates at the extractor spigot. When a black wake shows behind this tyne a spigot product is ready, though in washing gravel where there is a dearth of black concentrates it is sometimes advisable to draw off at regular intervals. Concentrate is run into headpans and is carried to the sizing trommel. If input material in the pans is too sandy the tynes eventually jam and have to be dug out before concentration can re-commence. When there is danger of this happening it is found that feeding overburden now and again effects a cure—the ideal puddle is muddy. Ninety per cent. diamond recovery is got from the first treatment pan. Meanwhile the wash which has overflowed to the second treatment pan goes through the same process, the native in charge drawing off at longer intervals. The spigot product of the second pan is more finely divided than that of the first pan; roughly 10% recovery of diamonds comes from the second pan.

The overflow from the centre of No. 2 pan flows to dewatering trucks which are fitted with pipes or weirs in their sides over which water decants. The trucks when full are trammed to the tailings dump for unloading. Much of the water returns by launders to the settling tank where it is pumped to the tanks at the top of the plant for re-circulation.

The next process to be considered is the sizing or grading of concentrate. This is done in the sizing trommel already described. The pan spigot product is placed in the feed chute where it is fed with water to the trommel. The spray of water along the length of the trommel retards blinding of the screening, but even so the 2 mm. sieve screen usually blinds badly if the native in charge stops tapping it for any appreciable length of time. Care must be taken that this boy is not over energetic in his attentions because holes in screening spell bad sizing.

Below the sizing trommel are four bins, namely: (1) for fines − 2 mm. sieve; (2) for medium gravel − 4 mm. sieve; (3) for coarse gravel − 7 mm. sieve. All matter + 7 mm. sieve falls out at the end of the trommel into the oversize bin. The sized product or concentrate is now carried to the appropriate jig feed box.

Puddling of Clay.—Before considering the question of jigging it is necessary to discuss the operation of puddling stiff clays. As clay, especially when wet, is difficult to remove from trucks the tendency is to make the feed to the puddling machine intermittent if only one chute is used. To overcome this difficulty a double chute was designed and by this means while the elevator belt is being fed from one chute a truck can be unloaded into the other. In this way a continuous feed is maintained. Clay travels up the elevator belt and falls on to a bar grizzley and while being flushed with water it is pushed through the bars by boys using spades. All oversize boulders are carefully washed clean in the feed water. On falling into the puddler box the clay is met by rotating beater bars which revolve at a speed of 135–150 r.p.m. Soon the clay approaches a mud in consistency and as water flows in it is carried the length of the box and out over a wooden baffle into a launder giving access to the shaking table. The impact side of a puddler box is lined with rubber which prevents the breakage of diamonds during the puddling operation. The shaking table is fitted with $\frac{5}{8}$ in. mesh screening and all material passes under a strong spray of water. Oversize tailings drop into a hopper for the purpose and the wash falling through the screen flows to the first treatment pan already described.

Jigging of Concentrates.—From the jig feed box the concentrate passes into the jig bed by gravitation; the heavier and larger particles gradually find their way down to the jig screen whilst quartz and material of like specific gravity concentrate on the top of the jig bed and eventually pass over the tailboard of the first compartment to the next one, where the process is repeated. All the largest concentrates are found in the first compartment of each jig and hence the majority of the diamonds. Occasionally the largest diamonds may be found in the second compartment, that is if they are cleavage plates of octahedra or flat twin crystals which present a greater surface to the flow of water. When a jig is ready to "clean up" black concentrate should just be seen starting to pass over the tail of the first jigging compartment. The jig then is stopped, the feed water cut off and the jig bed dewatered by opening the spigot at the bottom of the jig hutch or well.

The first operation is to scrape obvious tailings from the top of the jig bed; next the middlings or indeterminate matter is scraped off and returned to the jig feed box for re-treatment. Concentrate next is

cleaned out into headpans, and the final cleaning of the screen is effected by means of a wire brush. After every "clean up" the jig screens are examined by the head jig-boy or European in charge before jigging is resumed.

Europeans are generally expected to be present when jigs are cleaned up to obviate pilfering. The jig treating the largest size of gravel is at all times cleaned up by the European, and it is advisable that this jig be locked in some way when treatment is in progress. After a little practice even fragmentary diamonds can be picked out by their greasy lustre and those displaying crystalline form are also easily recognizable. Generally speaking, concentrate recovered is in the proportion of approximately 0·8% to 1% of the entire wash treated. The minerals found in concentrates have already been mentioned, but those most generally found are garnetiferous sand, ilmenite, magnetite, quartz, muscovite, biotite, staurolite and occasionally particles of gold.

Sorting.—After concentrate has been cleaned up in the jigs it is sent to the sorting sheds. The term sorting here used must not be confounded with classification or grading, as it merely means "a picking out." Labour employed for this task comprises native women and girls, and young girls frequently make excellent sorters as their eyes are generally much sharper. To sort concentrate it is placed in a headpan, the inner surface of which has been smoked or dulled over a slow wood fire. The pan is filled to approximately $\frac{1}{4}$th of its capacity, the concentrate being stacked on the side of the pan farthest from the sorter; next a small amount of clean water is poured into the headpan to a depth of about one inch. Using a bamboo splinter the concentrate is scraped through the shallow water. When a diamond is scraped through the water it gives a flash and so can be picked out. As there is a wide margin of refractivity between the diamond and water (n respectively 2·52 and 1·33) the phenomenon of the flash is easily accounted for.[1] Sorting cannot be carried out in bright sunlight or in artificial light. Sorters place the diamonds recovered in small galvanized iron boxes in the lid of which are funnel-like tubes down which the stones are dropped. These receptacles, which are clamped to the sorting bench, have removable trays inside and can be opened only by the European in charge. Concentrate which has been sorted once is placed on a special dump and it is from this stone that re-sorters draw their concentrate. Re-sorters generally work on contract, to obtain a fixed number of stones per mark or day's task. The re-sorting or concentrate may be carried out three or four times. The magnetic separator is now being used with success, and makes the employment of larger numbers of sorters unnecessary.

The final sort or clean-up is carried out by the European in charge, who weighs the stones by sizes and reports his recovery and yardage treated to headquarters.

The author gratefully acknowledges the encouragement and advice given him by Mr. G. P. Ashmore, of the West African Diamond Syndicate, and by Professor Henry Briggs.

[1] Kraus and Holden, "Gems and Gem Minerals" (McGraw-Hill), Chap. IV.

THE LAKE SUPERIOR IRON ORE INDUSTRY

By ROBERT S. LEWIS

The author, who is professor of mining in the University of Utah, deals with some economic features of this enormous industry.

The Lake Superior iron region comprises the Menominee, Marquette, Gogebic, Cuyuna, Mesabi, and Vermillion ranges in the United States and those in the Province of Ontario, Canada. The Canadian deposits are not being worked at present. In general, the iron formations are Pre-Cambrian cherts or jaspers, thought to be derived from sedimentary rocks containing about 25% iron, in which the iron was originally present as a carbonate or silicate, but which later became oxidized. These formations were folded and faulted, and intruded by igneous rocks. Circulating waters carried away silica in solution, leaving behind the iron oxide as a porous material which slumped together to form the iron ores. In places, the original iron content has been enriched and locally, through alteration, the ore is a hard magnetite or hematite. Most of the ores are a soft limonite or hematite. The region is almost entirely covered with glacial drift. The first

BESSEMER ORES

Range	Long Tons.	Iron, Natural.	Phos.	Silica.	Mn.	Moisture.
Mesabi	9,998,773	54·21%	·039%	8·28%	·40%	9·75%
Vermillion	1,195,884	58·12	·043	6·14	·12	6·71
Cuyuna	179,806	53·18	·044	12·53	·16	10·23
Gogebic	1,814,231	54·14	·041	7·41	·36	11·07
Marquette	99,767	57·30	·042	6·72	·15	7·84
Menominee (1929)	91,241	54·58	·045	5·12	·20	6·30
Non-Bessemer, Low Phosphorus (Under 0·18%)						
Mesabi	24,825,865	50·12	·073	7·86	·76	13·16
Vermillion	458,905	58·26	·098	7·13	·11	5·14
Cuyuna	238,020	50·14	·125	10·52	·53	9·12
Gogebic	3,847,705	52·09	·081	7·23	·75	12·95
Marquette	2,796,831	53·59	·100	7·89	·32	9·67
Menominee	1,406,949	51·37	·063	9·47	·23	6·95
Non-Bessemer, High Phosphorus (Over 0·18%)						
Cuyuna	419,866	51·17	·262	8·33	1·10	9·34
Marquette	508,736	50·64	·273	7·95	·47	12·5
Menominee	3,010,842	51·25	·48	6·72	·31	8·55
Siliceous Ores (Silica 18% and over)						
Gogebic	32,469	32·25	·052	38·59	·35	8·93
Marquette	844,795	35·92	·048	41·43	·14	3·97
Menominee	11,902	43·65	·04	30·00	·12	3·0
Manganiferous Ores (Manganese over 2%)						
Mesabi	57,179	41·07	·131	9·46	3·44	17·42
Cuyuna	1,145,830	37·34	·245	8·83	9·02	15·19
Gogebic	782,479	49·73	·061	9·39	4·10	9·65
Menominee	369,147	45·06	·542	7·79	4·85	7·23

ore-bodies found had visible outcrops, but prospecting is now more difficult owing to the covering of glacial drift and areas of thick vegetation. Toward the western end of the Mesabi range the silica content of the ores is high. Such "wash" ores require concentrating to form saleable products. At the eastern end of the range are large tonnages of low grade magnetite ores. The Cuyuna range is noteworthy because of the high manganese content, up to 35%, of some of its ores.

The Lake Superior Iron Ore Association classifies the ores into five main divisions: Bessemer ores containing less than 0·045% phosphorus, low phosphorus non-Bessemer ores with phosphorus under 0·18%, high phosphorus non-Bessemer ores of more than 0·18% phosphorus, siliceous ores containing over 18% silica and manganiferous ores which contain over 2% manganese.

The average analysis of ores from the various ranges for 1928 is given in the accompanying table.[1]

Iron, natural, is the iron in the ore taking into account the condition of the ore at the time of sampling. Thus for an ore containing 58% iron, on a dry basis, and 11% moisture, the iron natural is $(100\% - 11\%) \times 58 = 51{\cdot}62\%$.[1] The ton used in the iron industry Bessemer and non-Bessemer ores, the common is the long ton of 2,240 lb. In valuing both basis of calculation is 51·5% iron natural for both classes, but with 0·045% phosphorus (dry) as the maximum limit for Bessemer ores. For the iron content, the "base unit" is found by dividing the base price by the natural iron content. Thus the base unit, for a base price of $4.50 a ton at the unloading ports on lake Erie, would be $4.50/51.5 = $0.08738.

For ores containing more than 51·5% iron natural, the value is found by multiplying its iron content by the base unit. An ore containing 55% iron natural would be worth $55 \times \$0.08738 = \$4{\cdot}81$ per ton.

For an iron content below the guarantee of 51·5% iron natural deductions are made.

Iron Content.	Deductions.
51·5 to 50%	Base unit or $0·08738
50 to 49%	150% of base unit or 0·13107
Below 49%	200% of base unit or 0·17476

The deductions for an ore containing 47% iron would be :—

51·5 to 50	= 1·5 units	× 0·08738	= 0·13107
50 to 49%	= 1 unit	× 0·13107	= 0·13107
49 to 47	= 2 units	× 0·17476	= 0·34952
			0·61166

[1] From Mining Directory of Minnesota, 1930, by J. J. Craig, University of Minnesota, *Bulletin* 21.

[1] "The Iron Ore of Lake Superior," by Crowell and Murray, 1927, contains much information on the industry.

The value of the ore is then the base price of $4·50 − ·61166 = $3·89. For Bessemer ores, there is a bonus if the phosphorus is below the guarantee of 0·045%. This bonus is variable, but ranges from $0·008 for 0·044% phosphorus to $0·71 for 0·005% phosphorus.

Commonly, manganese under 5 to 6% is counted as iron. Ore containing more manganese receives a special price, but a guarantee is required for both the iron and manganese contents. Siliceous ores, containing over 18% silica, are sold at special prices.

Mining Operations.—The deepest mines, reaching to some 2,500 ft., are on the Marquette range. On the other ranges the mines are shallower, especially on the Mesabi range where 500 ft. is about the limiting depth. In some localities the dip of the ore is such that open-pit and underground mines adjoin each other. Open-pit mining predominates on the Mesabi range. As a general ratio, where the vertical depth of stripping does not exceed 2 ft. for each foot in thickness of ore, 1 cu. yd. of stripping to 1 ton of ore is taken as the limit for open pit mining. As large scale operations reduce costs, this ratio has been exceeded at some open-pits. A 1 to 1 slope for the sides can be used in the average overburden, but in case fine sand, swamp material or where much water is present this slope must be flattened to 2 or 2·5 to 1. Of some 100 producing mines on the Mesabi Range nearly two thirds are open-pit mines. These mines produced nearly 80% of the ore mined on the range in 1928 and some 10 mines supplied half the production from the range.

Two open-pits are fully electrified; the Wabigon mine at Buhl, Minn., electrified in 1924 and the Mesabi Chief mine at Kewatin, Minn., electrified [1] in 1928–29. Stripping shovels have 8 cu. yd. dippers and shovels working in ore have 4 cu. yd. dippers.

The open-pit mine at Hibbing is the largest open-pit iron mine in the world. Comprising an area of 1,060 acres, its dimensions are as follows: length 2·5 miles, width ½ to 1 mile, greatest depth 350 ft. It contains 66 miles of standard gauge track. Stripping was started in 1895, and to May 1, 1930 a total of 103,244,400 cu. yd. of stripping and 204,116,753 tons of ore had been removed. Both steam and electric shovels are used, sixteen in all. The benches of the pit vary in height from 20 to 70 ft., with 25 to 30 ft. as the average.

Fig. 1.—Steam Shovel loading ore from Stock-pile: Maas Mine, Cleveland Cliffs Iron Co.

At the Susquehanna mine, adjoining the big pit, steam locomotives had been hauling ore out of the pit over some two miles of track on a 4% grade. To lessen the cost of operation a 5 compartment shaft has been sunk about 150 ft. from the wall of the pit and a connecting haulage tunnel has been driven to the shaft. Differential Steel Car Company's motorized cars, operating under 600 volts d.c., are used to pull 6 trailer cars. Both motor car and trailers hold 4½ cu. yds. each and can be dumped on either side. The motorized train saves some 18% in weight, when light, and 10% in weight, when loaded, over the steam equipment formerly used.

The principal methods of mining used underground are top slicing, sub-level caving,

[1] See description in "Some Recent Developments in Open Pit Mining on the Mesabi Range," by E. E. Hunner, Tech. Paper No. 333 Am. Inst. Min. and Met. Engns.

and sub-level stoping. For the hard ores, where the surface cannot be disturbed, approximately half the ore must be left in place. In top slicing, the use of wire fencing placed over the timber floor after a slice has been mined largely prevents accidents from falling rock during the mining of the slice below. Commonly, 4 in. Ellwood fence netting, type F, is used.

Open-pit mines are either shut down in winter or work in them is confined to straightening up the pit and doing some stripping. The underground mines work throughout the year, but due to the Great Lakes freezing in winter, the ore is placed in stockpiles. When lake traffic opens in the spring, steam shovels are used to load the ore into railroad cars (Fig. 1). Stockpiles are made at a number of mines by running automatic-dump cars out from the shaft over either wooden or steel trestles. Wooden trestles are cheaper, but are practically destroyed by steam shovels while loading the ore. Steel trestles are more permanent and economical. The illustration (Fig. 2) shows a steel trestle averaging about 35 ft. in height. The columns are 114 ft. apart and carry two tracks, 20 ft. centre to centre. The arms of the columns are designed to carry a load of 10 tons each. The columns are made from $\frac{1}{4}$ in. boiler plate and are filled with concrete. They are 4 ft. in diameter at the top and 6 ft. in diameter at the bottom and are bolted to a concrete base. The wooden cars hold 65 cu. ft. or 4 tons. They dump to the side and are automatically operated by a bumper block placed at any desired point along the trestle. The cars are pulled out on the trestle by an endless rope which operates continuously, but the cars

FIG. 2.—STEEL TOWER FILLED WITH CONCRETE IN STOCK-PILE CARRYING ABOUT 2,000 TONS OF ORE PER LINEAR FOOT OF TRESTLE.

return under the influence of gravity, so the trestles slope slightly toward the shaft. The stockpile shown contains about 2,000 tons per lineal foot of trestle.

Due to the severity of the winter, many mines have a covered track through the timber yard (Fig. 3). Doors open along the sides and the mine timbers, which have been stacked in large piles, are rolled on to a timber truck. The track leads into a concreted tunnel, which extends some distance out from the shaft, starting at a point some 30 ft. below the surface. Men walk down steps from the change room to this loading station, and thus avoid being chilled by the cold air on the surface.

Many mines are operated on leases from the land or fee owners and the royalties paid constitute an important part of mining costs (Fig. 4). The owners or their agents maintain a close watch over underground or open-pit operations and are interested in securing complete extraction of the ore, if this is possible. One company, which crushes and screens its ores, maintains four separate dumps, one for each lease in the mine.

FIG. 3.—MINE TIMBER AND COVERED TRACK TO SHAFT: ATHENS MINE, CLEVELAND CLIFFS IRON CO.

Another mine has favourable royalty terms, but a short term lease. Power is supplied over three separate lines to insure uninterrupted service. Spare steam pumps are placed near the electric pumps in the mine and, in case electric power is cut off, a steam locomotive can be connected to the steam line near the collar of the shaft to prevent flooding of the mine.

For underground mines on the Menominee, Gogebic and Marquette Ranges in Michigan, the State Tax Commission gives the following costs for 1929[1]:—

Mining, per ton	$1·32	to $1·84
Taxes	·21	·29
General overhead	·14	·27
Transport	1·39	1·45
Marketing	·05	·095
Royalty	·15	·36
Interest on borrowed capital	·01	·03
Total costs	3·55	4·23

Average Costs for Open Pit and Underground Mines, Mesabi Range.[2]

	Labour.	*Supplies.*	*Mscl.*	*Development.*	*Royalty.*	*Total.*
Open Pit	$0·146	0·148	0·165	*0·305	0·438	$1·202
Underground	0·947	0·428	0·220	0·089	0·466	2·150

* Includes stripping costs.

The following costs are taken from U.S. Bureau of Mines Information Circulars #6410 by C. A. Jackson and #6138 by Lucien Eaton.

	Direct Mining Costs per Ton of Ore Hoisted.	*Tons per Man Shift all Underground Labour.*
Parallel top slicing, scraping to cars.	$1·165	7·49
Parallel top slicing, scraping to chutes	1·095	8·87
Radial top slicing	1·366	7·77
Sub-level caving	1·537	5·72
Sub-level caving	1·279	5·98
Room and pillar, hard ore	1·412	6·10

BENEFICIATION OF LOW-GRADE ORES.—The present system of taxing ore reserves has resulted in limiting the developing of ore-bodies to the immediate needs of mining and no farther, but it is felt that within 15 or 20 years there will be a scarcity of ores of sufficiently high grade for direct shipping, especially if the yearly output should be increased. (Shipments reached the peak of 65,204,600 tons in 1929.) If the mines were worked to maximum capacity the present yearly output could be nearly doubled.

[1] Costs and Production of Michigan Mines. F. G. Pardee. *Eng. and Min. Jour.*, Aug. 9, 1930.

[2] The Mesabi Range. W. L. Taylor. *Min. Cong. Jour.*, October, 1929.

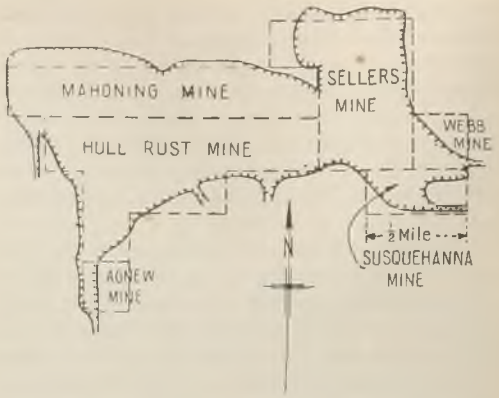


FIG. 4.—LARGE OPEN-PIT IRON MINE, HIBBING-MINNESOTA, SHOWING DIFFERENT LEASES.

Thus it is evident that the future supply of iron ore must come more and more from the large reserves of low-grade ore. The methods of treating these ores are: drying, sintering and nodulizing, crushing and screening, and washing, including jigging in some cases. Drying is used to remove part of the water from ores of high moisture content, say from 12% down to about 7%. Sintering and nodulizing are used to agglomerate fine material. Crushing and screening removes the larger pieces of waste from the ore. By washing and jigging much sandy waste can be eliminated. At present, magnetic concentration is not being used. In 1923 more than eight and a half million tons of ore were beneficiated. In 1929 the following tonnages of beneficiated ores were shipped from Minnesota.

From washing[1]	5,874,028	or 36·7%
From jigging	84,000	0·5
From sintering	224,063	1·4
From drying	341,759	2·4
From crushing and screening	9,455,553	59·0
	15,979,403	100·0

The above tonnage constitutes 33·7% of all the ore shipped from the Mesabi, Vermillion and Cuyuna ranges in Minnesota. In 1926, the tonnage of beneficiated ores from Minnesota was 15,1010,77 tons as against a combined total of 6,423,990 tons from Michigan and Wisconsin mines.

[1] Mining Directory of Minnesota, 1930. J. J Craig. Univ. of Minnesota *Bulletin* 21.

As an illustration of the results secured by washing ores, the following table covers a nine year period of operation of the Hill-Trumbull concentrator at Marble, Minn.

	Tons.	*Iron.*	*Phosphorus.*	*Silica.*
Crude Ore treated [1] . . .	4,636,237	43·70%	0·046%	31·30%
Concentrates produced . .	2,988,095	59·78	0·059	7·46
Average percentage recovery in tonnage . .			64·45%	
Average percentage recovery of iron . .			88·17%	

Washing the sandy ores has been practised for 20 years and millions of tons of tailings have accumulated. Tailings originally contained from 20 to 25% iron, but fine sand and slimy iron were carried away by wind and water to the edges of the ponds or outside by floods. The remaining natural concentrate now assays 45 to 50% iron. Concentration tests on this material have shown favourable results.[2]

TRANSPORT.—By far the greater part (97%) of the ore from the mines, goes by railway to the docks at the loading ports of Two Harbors, Duluth, Superior, Ashland, Marquette, and Escanaba. The docks range in length from 900 to 2,304 ft. The largest docks are 84 ft. high and have 384 ore-pockets of 400 tons capacity each. The pockets are 12 ft. wide. This distance corresponds with the 12 ft. spacing of hatches on the ore-carrying steamers. The four railway tracks on the top of the dock will accommodate 384 cars at one time. The map, Fig. 5, shows the tonnages handled by the different railways and also the distribution of the ore to the various unloading ports on the Great Lakes.

Freight rates from the ranges to the loading docks are as follows: To Marquette \$0·54 to \$0·60 per ton, to Escanaba and Ashland \$0·72, and to Duluth, Superior, and Two Harbors \$0·81 per ton. The number of boats to be loaded at a dock within the next 24 hours and the desired cargo are known. Since the boats must be loaded to within 1% of the desired analysis on which the ore is sold, the ore trains must be made up to give the desired cargo. For this reason, the railways have supporting yards from 1 to

[1] Beneficiation of Hill-Trumbull Mine Ores. H. C. Bolthouse. *Min. Cong. Jour.* Oct. 1929.

[2] Concentration Tests on Tailings from Washing Plants of the Mesabi Range, Minnesota. F. D. DeVaney and W. H. Coghill. U.S. Bureau of Mines Reports of Investigations, 3052.

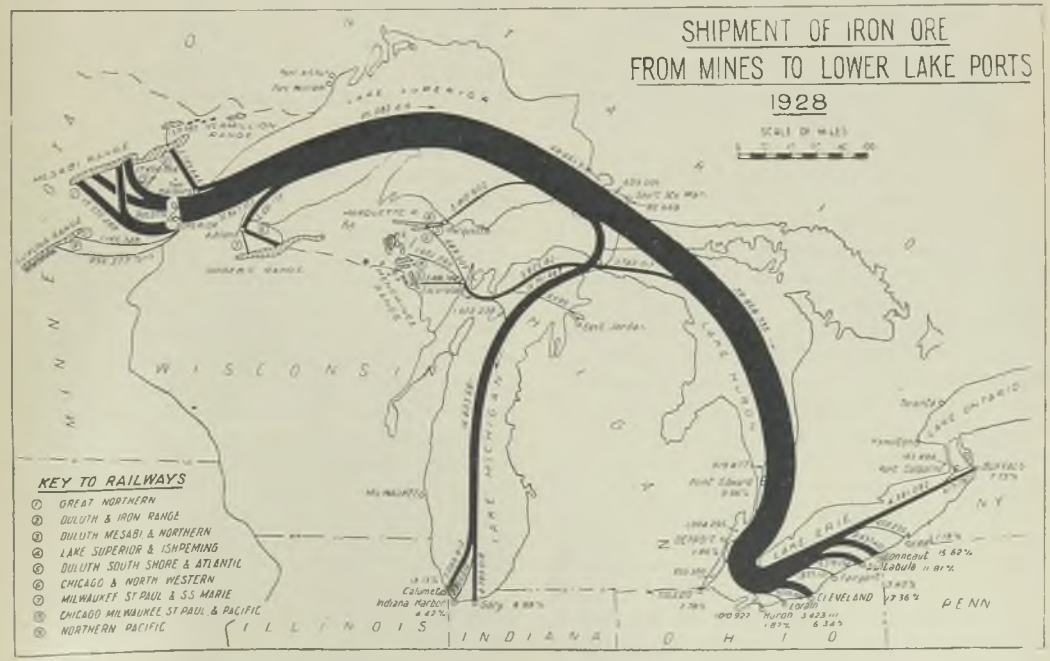


FIG. 5.—COMPILED FROM MAPS AND DATA IN "TRANSPORTATION ON THE GREAT LAKES," BY THE CORPS OF ENGINEERS, U.S. ARMY AND U.S. SHIPPING BOARD, 1930.

8 miles distant from the docks. At these yards, the cars of the incoming trains from the mines are sorted to make up trains of a desired ore content. Cars are sampled at the mines and usually the samples are combined in composite five-car lots for analysis, the reports of which are sent to the yards. The largest yard is that of the Duluth, Missabi and Northern R.R. at Proctor, 8 miles from Duluth. Its capacity is 1,500 empty cars and 2,800 loaded cars. Trains are made up into lots of from 75 to 100 cars, which range in capacity from 30 to 100 tons. The writer was in Duluth just after the Fourth of July, 1930. Because of the holiday delay there was an extra rush of business. From 7 a.m. Saturday to Monday noon 44 steamers were to be loaded, and from 7 a.m. Saturday to 7 a.m. Monday 4,400 cars were to be unloaded. For 1929, the average cargo of iron ore was 9,494 tons. In August 1929, the steamer James Pickands carried 14,436 tons from Escanaba to South Chicago.

Loading charges at the docks total 10 cents per ton for unloading, storing in docks, and loading into steamer, if the boat reaches the dock within 10 days from the arrival of the cars at the dock. The lake freight from Two Harbors, Duluth, Ashland and Superior to the Lake Erie ports is 70 cents per ton, from Marquette 63 cents per ton and 52·5 cents per ton from Escanaba. It is 42 cents from Escanaba to Chicago. Unloading at the lower lake ports costs 13 cents per ton from hold to rail of vessel, and 8 cents a ton from rail of vessel to railway car. If the ore is taken to stockpiles, the charge is 20 cents a ton from rail of vessel, and a charge of 13 cents a ton is made for loading cars from stockpiles. In general, there is a loss of 1% of ore from the mines to the railroad cars at the unloading ports.

Railway rates from Lake Erie ports to the furnaces varies from $3·16 per ton from Erie to Lebanon, Pa., to 74 cents a ton from Cleveland to Columbus, Ohio.

Base prices for iron ore at the lower lake ports in 1929 are given below :

	Marquette.	*Menominee.*	*Gogebic.*	*Vermillion.*	*Mesabi.*
Bessemer . . .	$4·80	$4·80	$4·80	$4·80	$4·65
Non-Bessemer . .	4·65	4·65	4·65	4·65	4·50

BOOK REVIEWS

Zinc and Lead Deposits of Canada. By F. J. Alcock. Geological Survey of Canada Economic Geology Series No. 8. Paper covers, 406 pages, illustrated, with map. Price 75 cents. Ottawa : Department of Mines.

It was the experience of the reviewer, during the three months he spent on various mining areas in British Columbia two years ago, that his only sources of reliable information about old mining properties were the various publications of the Mining Department of Canada, in particular their bulky Annual Reports, and the very useful and valuable volumes published under the general title " Economic Geology Series ", of which the present work forms No. 8.

A book of this kind, covering the zinc and lead deposits of so vast a country as Canada, is largely a compilation of what has already been published by the officers of the Mining Department. It is, however, something more than this, for the author has exercised sound judgment in retaining brief, but useful, descriptions of interesting mineral occurrences on small unworkable properties and has omitted long descriptions, not now of interest, of properties which once loomed largely in the public eye. Where the evidence is sufficient, conclusions as to the genesis of the ore and the temperature conditions which obtained during mineralization, are given clearly and concisely. The first chapter gives, in seven pages, a brief and interesting historical sketch of lead and zinc mining, a list of the various lead and zinc minerals, and a generalized statement of the Canadian production. The mineralogy of lead and zinc occupies the 12 pages of Chapter 2, and the modes of occurrence of lead and zinc ores are well summarized in the 21 pages forming Chapter 3. Chapters 4 and 5 make up the main portion of this book of 406 closely, but clearly, printed pages. Chapter 4 contains descriptions of the lead and zinc mining areas of Eastern Canada, carefully summarized within 185 pages ; and Chapter 5 those of Western Canada which, although of far greater economic importance than the former, occupy only 133 pages. The clear reproduction of the 8 map-plates and 34 photographs which illustrate the volume, reflects credit on the publishers.

This carefully summarized and well annotated account of the lead and zinc

deposits of Canada is based on information that was available to the author before the close of 1928, and the latest statistics given at the end of the book are for the year 1927.

WILLIAM R. JONES.

Handbook of Cornish Geology. By E. H. DAVISON. 2nd edition. Paper boards, 114 pages, illustrated, with map. Price 6s. Truro: Oscar Blackford.

The second edition of this handbook contains ten chapters of letterpress, a useful bibliography, and ten illustrations. It will be welcomed by students and also by the general public for it supplies a concise and clear account of both the geology and the lodes of the Duchy. Readers who in the past have attended the Summer Course of the Camborne School of Metalliferous Mining under the guidance of the author will have many pleasant memories of their journeys brought back to them by this book.

The author first deals with the Lizard and supplies an outline of the coloured Geological Survey map by Sir John Flett: then with the stratigraphy of Cornwall and points out some problems that await solution, for instance, the age of Hill's Portscatho-Mylor-Falmouth Series and of the Grampound-Manaccan Beds. He next briefly describes the basic igneous rocks, but one would like further details as to the difference in character between the proterobases of the Padstow area and those of St. Minver (pp. 34, 35). His account of the granites, hypabyssal rocks and the contact alteration is clear and useful. The tables in Chapter VIII seem, however, to require some explanatory notes, for example, on p. 57 as to why " calc-flinta " is included as a product of tourmalinization. The list of localities where typical sections can be examined is likely to prove of value to visitors.

The economic geologist will read with profit the chapters on the lodes of Cornwall and the china clay deposits and will also find the map at the end of the book useful for reference as it shows the position of the working, and of a number of the old, mines. Some printer's errors have escaped correction, but these do not detract from the interest and value of the book.

HENRY DEWEY.

Handbuch der Geophysik. Vol. III, Part I. Paper covers, 570 pp., illustrated. Price, 48 RM. Berlin: Gebrüder Borntraeger.

In reviewing earlier parts of this handbook special mention has been made of the comprehensive and interesting manner in which the subject has been treated. The part now under review is the work of four contributors, each dealing with a branch on which he is a specialist and the high standard reached in the previous parts has been well maintained, as might be expected from such authors as Gutenberg, von Wolff, Born and Hess.

After a short introductory section on the strength of the earth's crust by Gutenberg, von Wolff, in an authoritative treatment extending over 300 pages, discusses the plutonic and volcanic theories in detail. The next section, by Born, is devoted to movements of the earth's crust, and starting from the elementary conceptions of stress and strain, gradually leads up to a consideration of some of the more complicated movements. This is followed by a section by Gutenberg on the various geotectonic hypotheses, while the book concludes with a section on the mechanical action upon the earth's crust of ice, water, and wind.

This part of the work should prove of particular interest both to the geologist and the geophysicist, while to the applied geophysicist, who is concerned with the location and delineation of structural features, it will provide a valuable exposition of the causes and occurrence of the irregularities which it is his function to locate.

H. SHAW.

Verwertung magnetischer Messungen zur Mutung. By PROF. ALFRED NIPPOLDT. Cloth, octavo, 74 pages, illustrated, with 36 plates. Price 16.50 RM. Berlin: Julius Springer.

This is a publication of an unusual type written for the practical man who, after the completion of a geophysical survey by the magnetic method, is desirous of interpreting the results of his survey. In modern publications on geophysics detailed instructions are frequently given on the methods of conducting observations and on field procedure, but with the exception of occasional theoretical papers of an abstruse nature, little is published concerning the art of evaluating the measurements and interpreting their actual significance. This is

attributed by Nippoldt to the fact that the technique of interpretation is regarded as the " trade secret " of the exploration companies. In this small book the author has endeavoured to place the information available before the mining engineer in a form such that it is readily adaptable to varying practical conditions. The main portion of the book consists of tables and curves dealing with typical individual cases, accompanied by a short and simple description of each. Naturally all the possibilities occurring in nature cannot be dealt with, but a varied and suitable selection has been made. No information whatever is given on the instrumental or observational aspects of magnetic surveying, but to those who are concerned with the interpretation of field observations it should prove invaluable.

H. Shaw.

Enstehung, Veredlung, und Verwertung der Kohle. Lectures given at Deutschen Technischen Hochschule in Prague. Published by order of Prof. K. A. Redlich, Prof. J. C. Breinl, and Priv.-Doz. H. Tropsch. Cloth, 359 pages, illustrated. Price 33 R.M. Berlin : Gebrüder Borntraeger.

The book contains lectures dealing with coal problems of outstanding importance and is well illustrated and indexed. R. Heinze contributes the longest article, which deals with " The Drying and Distillation of Brown Coal." An exhaustive and critical account of the methods used and a statement of the principle uses to which the products are put, together with statistics showing the various types of retort used, and the annual throughput, make the article valuable. H. Tropsch deals with the synthesis of organic compounds from gaseous coal products in a clearly arranged and up-to-date chapter. Researches on the constitution of coal are being pursued in so many directions that it is impossible to summarize them all in eighteen pages, but the article entitled " The Present State of our Knowledge of the Chemical Structure and Origin of Coal " (also by Tropsch) may be regarded as a careful statement of the most recent work. The importance attached to the study of the mechanism of combustion as affecting pulverized fuel firing and the burning of solid fuels generally, with the possibilities of mechanical combustion control are reflected by the inclusion in the book of three papers—" On the Combustion of Solid Fuel " (by Löffler), " The Szilka-Rozinek Pulverized Fuel Plant " (by Rozinek), and " Theoretical Basis of Mechanical Combustion Control " (by J. C. Breinl). Of these the last is perhaps the most interesting. The first might with advantage have been enlarged to allow of a more detailed discussion of the principles of pulverized fuel firing. A chapter worthy of careful reading is that by W. Petraschek on " The Connexion between the Properties of Coals and their Geological history." A particularly striking article is contributed by H. Apfelbeck. It deals with the representation of ultimate analysis of coals on a triangular diagram, by plotting the percentage of carbon, hydrogen, and oxygen along the sides of a triangle ; and the author indicates that such a diagram groups coals according to their " Inkohlung " (Internal Carbonization or " Rank "—this word is difficult to translate satisfactorily) in a convenient manner, and is valuable as an aid in choosing coals for a particular mode of utilization. An instructive collection of data concerning the energy requirements of the more important countries, with the distribution of coal, oil, and water power as means of meeting them is given by E. Kothny in an article entitled " The Economics of Coal as a source of Energy."

To summarize : the book covers a wide field and is a valuable addition to the literature of fuel technology.

L. W. Needham.

Elementary Economic Geology. By Prof. H. Ries. Cloth, octavo, 360 pages, illustrated. Price 18s. 6d. New York : John Wiley & Sons ; London : Chapman & Hall.

This book has been prepared as a text-book for use in a one-term course in economic geology. It differs from the well-known larger work by the same author in that an attempt has been made to emphasize the principles of the subject, with a corresponding reduction in the descriptions of individual localities, although a sufficient number are briefly described in order to illustrate the types of deposits to which reference is made. It is in this attempt to afford the student a sound knowledge of the underlying principles of the subject, on which he can build the superstructure of his later experience and learning without ever having to doubt their soundness, that the author's

success is open to question. There are many things which fall within the scope of economic geology which are unkown and about which we still only speculate. Two notable examples are the origins of coal and of petroleum. Both are matters which have given rise to numerous speculative theories and to much controversy, which will probably eventually lead to the explanations which are so urgently needed. In educating the budding geologist, however, it is highly important that the gaps in present day knowledge should be clearly impressed upon his mind and that he should realize that there are mysteries still to be solved. This understood, then a leaning towards any particular theories on the part of the teacher is permissible and will be given its proper value in the student's mind, but if that picture is not firmly impressed upon him in the first place he is apt to interpret theories as facts and accept as underlying principles matter which is merely speculation.

To take a concrete example from the present book we find on page 37 concerning the origin of oil that " oil is found almost exclusively in sedimentary rocks " and " that the latter often contain an abundance of plant remains," and on page 39 that " it is generally admitted that petroleum did not originate in the beds in which it is now found." The latter is by no means generally admitted and the former would certainly convey a picture of oil-bearing strata containing abundant fossil plant remains, though if the oil did not originate in those beds in which it is now found what the fossil contents of such rocks have to do with the oil is not quite clear. The origin of coal is attributed to the progressive metamorphism of peat after burial under sediments. This again is merely the speculation of one school of thought and no mention is made in the book to the fact that there is a growing body of thought which favours a sedimentary origin. As a condensation of the larger work this present book has undoubted value, but as a text-book for educational use in this country it is not likely to find favour, especially as the descriptions of individual localities given are almost entirely confined to American examples. Such examples from America are doubtless excellent and illuminating, but when the author ventures farther afield for his examples they become somewhat sketchy. The *faux pas* of describing the great Bawdwin silver-lead deposits of Burma under the heading of lead-zinc ores, which was criticized in the MAGAZINE in the review of the larger work, is again perpetrated in the smaller, while the Postmasburg manganese deposits of South Africa escape mention under the heading of manganese.

For those who desire a concise work on the economic geology of America, and the American views on certain outstanding problems in economic geology, the book can be recommended.

MURRAY STUART.

Outlines of Historical Geology. By Prof. CHARLES SCHUCHERT. 2nd Edition, rewritten 1931. Cloth, octavo, 348 pp., illustrated. Price 15s. New York: John Wiley, and London: Chapman & Hall, Ltd.

The well-known group of geological text-books originally prepared by the late Louis V. Pirsson and Charles Schuchert has lately been revised by Dr. Schuchert and his colleagues at Yale University, while additional shorter volumes suitable for elementary geology students have been produced. One of these additional volumes, " The Outlines of Physical Geology," written by C. R. Longwell, which incidentally can now be obtained bound up with the book under notice (" Foundations of Geology," Pirsson, Schuchert, and Longwell, 25s.), was reviewed in the February number of the MAGAZINE. The present notice deals with a rewritten edition of the elementary stratigraphy book first published in 1924 and designed for the use of civil and mining engineering students.

The letterpress is obviously designed for a North American public and as such, seems to be eminently suitable, accompanied as it is by a wealth of interesting and attractive illustrations. These comprise not only classical American geological sections and panoramas, but also restorations of the life of the various geological periods together with evolutionary series and comparative groups of various mammals. The collection of more than 50 revised reconstructions of North American geography at progressive time intervals is very instructive, as are the few reconstructions of world palaeography.

We feel that the student of American stratigraphy is fortunate to have such a book available for his study.

C. J. STUBBLEFIELD.

The Japanese Earthquake of 1923. By CHARLES DAVISON. Cloth, octavo, 127 pages, 40 plates and diagrams. Price 7s. 6d. London: Thomas Murby and Co.

In this country, earthquakes are things about which little is known to the general public, and therefore this lucid and simple account of the great Japanese earthquake of 1923, written by one of the leading authorities in the world, is particularly welcome. The first part of the book consists of a general account of the disaster and vividly portrays the wave of death and destruction which, without a moment's warning, swept across the country and converted a picturesque and unsuspecting land into a shambles. The second part, which constitutes more than half the book, describes, in non-technical terms, the earthquake as a natural phenomenon and explains both where it originated, and why. The book can be recommended to all, as being an authoritative account of a disastrous event in the history of the world, written in simple language by a master of his subject.

MURRAY STUART.

☞ Copies of the books, etc., mentioned under the heading "Book Reviews" can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C.2.

NEWS LETTERS

BRISBANE

April 20.

Mount Isa Nearing Production.—It has just been authoritatively stated that production will begin at the Mount Isa lead-silver-zinc mines on May 1. This announcement has relieved some anxiety, as an uneasy feeling was abroad that the extremely low price of lead and silver, to say nothing of zinc, might interfere with the bringing to fruition of the splendid work that has been done in carrying out the programme originally laid down. The completed Mount Isa mine has the most efficient and up-to-date equipment of any mine in Australia and it is expected to prove the cheapest producer of lead in the world. The newly appointed General Manager for the Mount Isa Company (Mr. Julius Kruttschnitt) recently stated that Mount Isa was all that had been claimed. Being a low-grade, but large, proposition, he affirmed, it will need to be worked in every branch by the most economical means. Three days ago the company, for the first time, began using the man and supply shaft for transport to the various levels. The cage, which is a massive steel structure 6 ft. by 12 ft. by 18 ft., is electrically lighted, is fitted with a telephone, and carries 35 men, all on one floor. The main haulage shaft will be ready to haul ore in about a week's time. At present between 1,000 and 1,100 men are at work; when production is commenced about 1,000 will be permanently employed. From reports from the field for March, as supplied by officials of the Queensland Mines Department, it is learned that two ore trains, each comprising 20 cars carrying 3½ tons of ore, will be run in the haulage levels—one from the Black Star lode, and the other from the Rio Grande and Black Rock lodes. The first bullion train is expected to leave Mount Isa for the coast early in June. The bullion will be shipped from Townsville direct to England, and will be refined by the Mining Trust, Ltd., near London.

Mount Morgan.—A fire at Mount Morgan has done a considerable amount of damage to the surface works. The chief injury included the destruction of ore-bins and a railway bridge which gave access to the concentrates, and which it is estimated will take £30,000 to rebuild. The loss of the bins will not considerably hamper operations at the mine, but the bridge destroyed carried the elevated railway that is needed for the conveyance of materials to the concentrates which the company was about to work. The concentrates are the product of the copper leaching operations that have long been carried on, first by the old and then by the new company.

Cloncurry Field.—In spite of the continued low prices of metals, a large quantity of ore was despatched from the Cloncurry field, North Queensland, during March, the bulk of it to the Chillagoe State smelters. The various consignments averaged 17% for copper and the greater part of the parcels came from four mines—the Mount Oxide, Trekelano, Orphan, and Dobbyn. The highest grade ore was despatched by the tributer at the Mount Elliott Company's Mount Oxide mine. When the new mineral find near Mount Isa was being examined for a flux proposition, assays showed both gold and silver. The auriferous

area is said to cover 60 acres, and the outcropping reef is 25 ft. wide. It is situated 2 miles from the latest silver-lead discovery, and 14 miles from Mount Isa. A company has been registered at Cloncurry to test the country.

Mount Coolon Goldfield.—Although water has of late been scarce on the Mount Coolon goldfield, in Central Queensland, the English company, Gold Mines of Australia, that has acquired mines there, is pushing ahead with prospecting work. About 50 men are employed, mostly underground. One shaft on the Coolon lease has been sunk from 140 ft. to 200 ft., and one on the Native Bear mine from 100 ft. to 300 ft. In the latter the reef has been cut and driving along it is being carried out. The same reef has been encountered higher up in another shaft, where it is 25 ft. thick and worth from £8 to £9 a ton.

Helping Coal Miners.—The Commonwealth Government has decided to make available £93,000 for the exploitation and development of shale-oil deposits in New South Wales, and £7,000 towards the relief of unemployed coal miners in Queensland. These two amounts total the sum promised some time ago to assist in repatriating surplus coal miners. A committee appointed by the Federal Government to control this expenditure is working on a proposal with the Australian Gas Light Company, which, with other companies, imports a large amount of oil for gas lighting. If guaranteed a continuous supply, this company would take from 80,000 to 100,000 tons of shale a year.

Australian Mineral Production.—The value of metals and other minerals won during 1930 in New South Wales was £10,095,700, a decrease of £2,750,800 compared with the output for 1929. Production of the State's coal output of 7,093,055 tons was the lowest since 1909. Its value at the pit mouth was £5,193,032, a decrease of £759,688 compared with the production of 1929. The gold yield showed an increase, being 12,493 oz. fine, valued at £53,066, or £21,224 more than that of the 1929 output. The production of minerals in Queensland for 1930, including gold, was of the value of £1,263,236, which was £443,943 less than the yield for the preceding year. The chief return was that of coal, of which 1,094,676 tons was produced last year and 1,368,745 tons in the previous year. There was a decline in the output of gold and all other minerals during 1930. In the first quarter of the year a small improvement took place in the gold output of this State for each of the first three months of this year. The gold yield for March in Western Australia (34,947 oz.) was the highest for that month in any year since 1924.

Oil From Coal.—There has long been a hope that the surplus coal of Australia would at some time be utilized for the production of oil, and this hope was strengthened by the motion recently passed in the House of Commons that it is desirable, for strategic and economic reasons, for the British Government to take energetic steps to encourage the use in the Navy of oil fuel made from coal. In the opinion of Dr. Rivett, chief executive officer of the Council of Industrial Research, however, low temperature distillation of black coal for the production of fuel oils does not offer attractive possibilities for Australia at present. This conclusion is given in a report submitted to the Australian Commonwealth Government following investigations abroad last year. Referring to the preparation of crude oil by the hydrogenation of black coal, Dr. Rivett says that this process is technically well developed, yet it could not compete economically on equal terms with natural oils.

VANCOUVER

May 6.

Consolidated Mining and Smelting.—The annual report of the Consolidated Mining and Smelting Company of Canada, covering operations for 1930, shows the net profits to have been $2,755,317 after providing for current development, depletion of property, and additions to the Employees' Pension Fund Reserve, as compared with $10,129,339 in 1929. The fall in earnings is attributable solely to the unprecedented drop in all metal prices, The decline in silver alone affected profits to the extent of about $1,000,000. Remarkable reductions in mining and concentration costs call for particular mention. At the Sullivan mine, ore has been crushed and delivered into the railway bins for less than 90 cents. per ton during the last four months of the period under review and at the Kimberley concentrator treatment costs have been reduced from 92 cents per ton to a fraction over 75

cents. A notable addition to the Trail works was the slag fuming plant, which is capable of recovering approximately 85 tons of zinc and lead daily from products which have hitherto been considered waste. Lead furnace costs were the lowest in the history of the company. This was due partly to the construction of another blast furnace, which is almost entirely new in design, being 50% larger than the standard size and 270 in. by 48 in. at the tuyere line. This furnace is equipped with water economizers and, although it smelts 50% more ore, it actually uses no more labour and less water than the others. The zinc plant also made a new record for costs during 1930. A very important advance in roasting the concentrates is reported, these being burnt in the same manner as powdered coal is fired. Although the process has been known for some years, this is considered to be the first really successful adaptation. The plant is now burning between 300 and 400 tons of concentrates per day, using no fuel whatever, putting over three times as much through the same furnaces with no additional labour, obtaining a higher recovery of zinc and gas highly suitable for making sulphuric acid. The first units of the fertilizer plant began operations early in the current year. Commercial sales of these products are reported to be surprisingly good, considering general conditions on the Canadian prairies. This plant should be in full operation shortly after mid-summer.

Granby Consolidated Mining, Smelting, and Power.—The annual report of the Granby Consolidated Mining, Smelting, and Power Company for 1930 must be considered as highly satisfactory in view of the unstable market conditions that prevailed. Despite curtailment of production at both the Anyox and Allenby plants, and the entire suspension of operations at the latter in November, a marked reduction in the average cost of refined copper is indicated—9·796 per lb., as compared with 10·614 cents for 1929. The refined marketable metals produced during the year amounted to 46,831,149 lb. of copper; 393,954 oz. of silver; and 8,435 oz. of gold, compared with 60,854,591 lb. of copper; 428,496 oz. of silver and 10,588 oz. of gold for 1929. The ore developed amounted to 2,471,624 tons and exceeded the total mined by 259,179 tons. At the end of the year, reserves are shown as 14,601,149 tons. The average grade of ore milled was lower, that at Anyox carrying 1·15% copper and at Allenby 1·34%, compared with 1·19% and 1·46% respectively for 1929. An improvement in copper recovery, however, is to be noted at Anyox mill, the percentage being 91·7 compared with 91·65, and a corresponding decrease in tailings from 105 to 101% for the past year.

Nelson Division.—Reno Gold Mines reports that during March the mill treated 932 tons of $16·50 grade, yielding a gold return of $14,600 with a 96·25% recovery. This property is situated in the Sheep Creek area and some 45 miles south of the city of Nelson. Recent developments on Nos. 3 and 4 levels has been in the sulphide zone and ore of this character now comprises the bulk of the mill feed. It contains sulphides of lead, zinc, and iron, but so far has presented no serious difficulty in its treatment by cyanidation. To meet these altered conditions, however, slight changes in the flow-sheet are deemed advisable, and are now under consideration. On the No. 4 level the ore-shoot has already been opened up to greater length than obtained at higher horizons, and shows improved width and value. A vigorous programme of development is now in progress, as well as lateral prospecting by portable diamond drill. A new level at the mill-site elevation will be started during the summer, when it is also intended to carry out extensive diamond drill prospecting from surface. It is unfortunate that this property is handicapped by excessive capitalization. It is announced that Arlington-Relief Mines will resume activities at an early date. The properties are situated in the Salmo district 13 miles north of Erie. The extreme drought conditions that prevailed last year necessitated suspension of work in the early autumn. However, approximately $23,000 in gold bullion and concentrates was produced, which covered all operation expenses and the purchase of new milling equipment. High gold values have been encountered in the upper workings and a new tunnel, started in 1930, has been driven 206 ft. of the 600 ft. necessary to tap the downward extension of the Second Relief vein.

Yale.—Some important results have been obtained from recent explorations of the old Emancipation mine by Dawson Gold Mines, Ltd. With a view to proving the continuation of the ore-body, from which former

owners obtained substantial returns, a tunnel was driven at 40 ft. below the old workings. It is reported that ore of $30 grade, having a mean width of 2 ft., has been exposed for a length of 120 ft. at this new horizon, as well as a shoot of considerably higher grade. This property is situated 17 miles from the town of Hope, near the Kettle Valley railway, west of Iago.

Cariboo.—Due to the mild winter, placer mining has been resumed fully a month earlier than usual. On Hobson Creek, adjoining Quesnel Lake and about 165 miles from Barkerville, the Hobson Creek (Cariboo) Mining Company has a force engaged on the completion of a flume that will provide for the installation of three additional monitors. It is expected that hydraulic operations will be started in July. At the Bullion mine, which is situated on the south fork of Quesnel River, a resumption of sluicing operations was made possible on the first of the present month by taking advantage of surface water. Moorhead Mines, Ltd., reports the resumption of work on the old Moorhead property, situated near the Bullion properties and about 50 miles north from Williams Lake station on the Pacific Great Eastern Railway. This company is owner of ten claims adjacent to ground that is reputed to have yielded over $400,000 to hand miners and Chinese in early days. Between 1913 and 1915 the property was worked when gold to the value of $17,000 was recovered from 130,000 cu. yd. of gravel. In the past the scope of operations was restricted by an inadequate water supply, but it is stated that additional watershed rights have been acquired by the present owners to ensure steady and augmented production.

Portland Canal.—The Consolidated Mining & Smelting Company reports that at the Big Missouri mine during 1930 underground work totalled 2,466 ft. in drives and cross-cuts but that these explorations failed to develop any definite ore-body, although muck samples occasionally showed values. Diamond drill prospecting amounted to 11,646 ft., which showed commercial ore over mineable widths in the silicified zone at various points over a length of 1,400 ft. Shipments from the Premier mine have been somewhat reduced during recent months. This company suspended operations at the Prosperity and Porter-Idaho mines on account of the low price of silver and the comparatively low grade of ore available. The B.C. Silver Mines, Ltd., continues operations on a limited scale and recent development has opened up the ore zone for an additional 50 ft. between No. 5 and No. 6 levels.

TORONTO

May 13.

Sudbury.—The International Nickel Company finds the demand for nickel gradually increasing and it is officially stated that the volume of sales is showing improvement. Good progress is being made on the new Orford-process building at Copper Cliff, which is expected to be completed by November. The separation of the precious metals from the base metal by this plant will materially add to the revenues of the company. It is estimated that some day the output of gold, silver, and platinum will pay the entire cost of mining, smelting, transporting, and marketing of all metals. A minimum of 300,000 oz. of platinum metals can be produced yearly without any appreciable additional cost to the production of base metals. The geological department of the company will this season undertake a survey of the company's properties in the district, in which it will have the assistance of Dr. L. C. Graton. The smelter of the Falconbridge was shut down on April 17 owing to an accident in one of the converter blowers and operations were not resumed until May 3. The company made a new high record for production for the first quarter of the year, producing 26,624 tons of ore which yielded 2,148,569 lb. of matte, containing 1,260,510 lb. of nickel and 514,031 lb. of copper. Preliminary drilling from the 700 ft. level shows ore widths considerably exceeding previous estimates. The Treadwell Yukon Company, operating the Errington mine during 1930, received a net amount of $115,155 from the sale of concentrates. Up to November 13 last, the date on which the mill was shut down, total ore treated was 64,859 tons, producing concentrates as follows: Copper, 3,469 tons; lead, 676 tons; and zinc, 5,062 tons. Diamond drilling on the 500 ft. level in the No. 1 shaft has disclosed a promising new ore-body.

Porcupine.—During April the six producing mines of this area yielded bullion valued at $1,681,805, from the treatment of

244,583 tons of ore. The annual report of the Hollinger Consolidated for 1930 shows a year of satisfactory progress, production amounting to $10,163,504, and the addition of other income of $639,427 brought the total revenue to $10,962,631, as against $10,167,207 for the previous year. Operating expenses totalled $6,529,900 which left the year's operating profit at $4,373,031. After deductions for depreciation, taxes, and the payment of dividends there remained a surplus of $519,728, making net surplus carried forward of $11,629,888. The value of the ore reserves is given at $48,806,685. During the first quarter of 1931, the mill treated 405,451 tons of ore, with a recovery of $2,613,342, an average of $6·44 per ton. For the first three months of the year the mill of the Dome mine treated 132,400 tons of ore, recovering bullion to the value of $842,382, an average of $6·36 to the ton. Since the beginning of the year the mill has been running at its rated capacity of 1,500 tons per day. The month of April showed the largest output amounting in value to $296,680, as compared with $258,635 in March. Development and exploration are being steadily continued and at the present time the reserves are stated to be in excess of 1,900,000 tons. At the McIntyre a section of the new mill is now in operation and the tonnage treated has been increased to about 2,000 tons per day. Diamond drilling from the end of the long cross-cut south of the Platt Vet section of the property has cut a 3 ft. vein, stated to average $13 to the ton. Development work on the lower levels shows that values are well maintained. The production of the March mine during March amounted to $22,000, which was a slight increase over the preceding months. It is proposed to extend the workings below the present depth of 675 ft. The Canusa will proceed immediately with the erection of a 50 ton pilot-mill and is carrying on an active exploration and development campaign. New areas at the Hayden property not hitherto prospected are being explored by diamond drilling and some good gold showings have been encountered.

Kirkland Lake. — Development work below the 2,000 ft. level at the Wright-Hargreaves has proved better tonnages of ore, with higher gold content and more consistent than those obtained on the upper horizons. It has been decided to sink a new central shaft, located about half-way between the present north and south shafts, to a depth of 4,000 ft. The mill is treating about 700 tons of ore per day of an average grade of $12. Lake Shore during the first quarter of 1931 recovered $2,325,000 from the treatment of 186,844 tons of ore, the largest production in any quarter of its history. Development work continues to open up consistent high-grade ore on the 2,200 ft. level and in 2,100 ft. of driving, average values of $30 to the ton have been obtained over widths of 8 and 9 ft. In preparation for sinking to a depth of 6,700 ft., the Teck-Hughes has started work on the cutting out of hoist chambers. While the sinking operations are under way the management will continue lateral work on the lower levels. Development is well advanced down to the 26th level where a large tonnage of high-grade ore has been opened up. The mill is now treating 1,250 tons daily with millheads running in the neighbourhood of $18 per ton. The Sylvanite is making good progress in shaft sinking and the objective of 2,500 ft. will shortly be reached. The mill is treating daily 270 tons of millheads averaging $10 to the ton. Diamond drilling indicates the continuance of the ore to the proposed new level and will be continued to lower horizons. The Moffatt Hall is resuming operations and has let a contract for shaft sinking to a depth of 150 ft. at which depth high-grade ore has been indicated by diamond drilling. The shaft of the Kirkland Lake gold mine is now down 4,725 ft. and when 4,750 ft. is reached a sump will be cut and cross-cutting will be started on three new levels. The average grade of ore going to the mill is between $12 and $14 to the ton as compared with millheads of around $6·50 a year ago. At the Macassa a new shaft is being sunk to a depth of 1,200 or 2,500 ft. An agreement has been entered into with the Kirkland Lake mining company under which their 2,475 ft. level will be extended into the Macassa property where it will connect with the new central shaft. The output of bullion in the Kirkland Lake district during April from the treatment of 137,838 tons of ore was valued at $1,791,144.

Rouyn.—The production of gold has for some time been a steadily increasing factor in the operations of the Noranda which, although primarily a copper mine, promises to become one of the largest gold producing mines in Canada. Diamond drilling has resulted in important new discoveries, a mineralized ore-zone with high gold and copper content having been encountered

about 2,200 ft. below the surface. The zone has an indicated width of 250 ft., a depth of 500 ft., and a length of approximately 1,000 ft. The No. 3 shaft which is rapdily approaching the 2,000 ft. level will be continued to 2,500 or to 3,000 ft. to enable the opening up of this deposit. One section of the concentrator will be turned over for the treatment of the high-grade gold ore. Shipments of anodes are being made regularly to the refinery and according to the present progress, finished copper will be on the market in about a month. Development work on the 625 ft. level of the Granada gold mine continues to bring to light high-grade mineralization. A new ore-shoot on the No. 2 vein has been opened up for 300 ft. and carries in places gold content averaging $20 to the ton. Gold values at this level are higher than those above. The reserves are about 14,000 tons of broken ore. An option has been taken by President Gamble on a group of claims in the Matachewan district. Work will be started on them at once and if they prove satisfactorily they will be turned over to the Granada Rouyn for development. During the month of April the Siscoe mine produced $65,798, from 4,780 tons, millheads running over $14 per ton. The new shaft is being sunk from 450 to 600 ft. A good ore reserve is being maintained with broken ore well ahead of milling needs.

Patricia District.—Gold production at Howey Gold Mines during April made a new high record with an output valued at $66,600, an increase over the preceding month of $6,600. A tonnage of 15,500 tons was treated with an average recovery of $4·30 to the ton. Operating costs were about $3·56 per ton leaving a net operating profit of 74 cents per ton. The quantity of broken ore in the stopes is about 132,000 tons. The Central Patricia Mines, Ltd., is being reorganized preparatory to the resumption of operations, a new company being formed under the name of the Central Patricia Gold Mines, Ltd., capitalized at $2,500,000. The Patricia Birch Lake Mining Corporation will carry on active development work during the summer ; a mining plant will be installed to carry the workings to a depth of 500 ft. Prospectors have been busy during the winter in the Pipestone Bay section of the Red Lake area, and several discoveries have been reported.

Manitoba.—The report of Sherritt-Gordon Mines, Ltd., which covers a period of 18 months terminating April 1, states that the ore milled averaged 3·5%, the indicated extraction well over 90%, and the grade of the concentrate produced 24%. Of the gold and silver content it was estimated that 70% would be saved and this figure has been realized. No mine development has been undertaken during the period under review, efforts having been directed towards the erection of the concentrator, and the preparation of the mine for production. Having completed and put into operation one unit there remains very little to do to complete the second. The president of the Hudson Bay Mining and Smelting Company, at the annual shareholders' meeting, dealing with the operation for the first quarter of this year—the figures for March being estimated—stated that the smelter treated 250,000 tons of ore and after all deductions returned approximately $4·90 per ton, in gold, silver, copper and zinc. Operating costs were $3·60 per ton, leaving an operating profit of $1·30. Two-thirds of the ore was taken from the open-cut which carries higher gold values than that underground. Shipments of concentrates are going forward at regular intervals. During the quarter approximately 30 cents per ton was charged against construction and winter hauling leaving a net profit of 40 cents per ton. The president pointed out that the company is selling all the zinc produced, which is of a grade comparable with the best turned out by the Consolidated Mining and Smelting Company.

JOHANNESBURG

May 7.

Proposed New Company.—The agreement concluded between the Lydenburg Gold Farms Company and the Union Corporation, whereby the corporation undertakes to expend £25,000 on the preliminary prospecting of the company's farm, Vlakfontein No. 21, in the Far East Rand, gives the corporation the right for a period of three years, renewable for one further year, to acquire the farm on behalf of a new company to be formed by the corporation with a nominal capital of £1,500,000 in £1 shares and a guaranteed working capital of not less than £150,000. The purchase consideration to be received by the Lydenburg Gold Farms Company is 125,000 shares in the new company. The

Lydenburg Gold Farms Company will participate to the extent of 20% with the corporation in the provision of the amount to be expended on preliminary prospecting, and is to receive 20% of whatever consideration the Union Corporation may receive from the new company in respect of the services it will render and the expenditure in connexion with the prospecting operations and the promotion and flotation of the new company. In addition, the Lydenburg Gold Farms Company is to be entitled to subscribe up to 20% of the initial working capital of the new company and is to be represented on the board of the new company.

Prospecting Activity in the Extreme East Rand.—One result of the visit of Dr. Malcolm Maclaren to the Rand, for the purpose of examining and reporting upon certain mining properties, is a renewal of prospecting and claim pegging activity in that portion of the Heidelberg district which may be described as the Extreme East Rand. The great Sugar-Bush fault which cuts across the country, roughly in an easterly and westerly direction, divides the Heidelberg gold-bearing area into two more or less distinct portions. The northern portion terminates a little beyond the southern boundaries of Nooigedacht No. 261, Houtpoort No. 309, Bothaskraal No. 207, and Blinkpoort No. 208. After three or four miles of amygdaloidal rocks in the same direction, there is a wide expanse covered by the Elsburg-Kimberley series, lying below the amygdaloid and dipping at a moderately low angle towards the north. Following this series comes the Main-Bird series, which runs for several miles east and west, approximately, through Rietfontein No. 244, Driefontein No. 280, Malan's Kraal No. 73, and Modderfontein No. 76. Occasional outcrops of quartzite with a small pebble conglomerate, representing the Nigel Reef, or grit, at its base, are found upon Tweefontein and Malan's Kraal, and can doubtless be penetrated at no great distance from the surface upon many points on the adjacent properties along the line. The area indicated is one that has been recognized as an auriferous belt for many years and claims have been continually held there for a very long period up to the present day by various people. In common with the remaining portions of the lower Heidelberg gold-bearing reef area, it has been prospected to a considerable extent. From time to time glowing reports of values at one point or another have been circulated, but until recently it has been neglected.

Deeper Mining on the Rand.—In the Village Deep section of the Robinson Deep, at a vertical depth of 7,500 ft.—the greatest depth at which mining operations are being carried on in the Witwatersrand field—a drive has been started, and for the first 45 ft. the values exposed show 10·1 dwt. over 45 ins. In view of this favourable development the Robinson Deep, Ltd., has decided to sink the Turf incline shaft to a depth of 8,500 ft., which is the limit of the hoisting capacity of the present equipment. In the Robinson Deep section the twin incline shafts have been laid out to reach a vertical depth of 8,200 ft.

Manganese Exports Increasing.—Shipments of Postmasburg manganese ore during the period July, 1930, to March 31, 1931, total 108,920 short tons and, despite the depressed state of the metal markets, the Manganese Corporation's monthly shipments continue to increase. Exports for April will be approximately 14,000 tons, and arrangements for May shipments cover approximately 18,000 tons. During the first three months of the present year shipments have been made to France, Poland, Great Britain, United States of America, Germany, Belgium, and Luxembourg. The general depression in the steel industries has greatly reduced the world consumption of manganese ore, although its effect on the demand for the higher grades, used in the manufacture of ferro-manganese, was not seriously felt before the beginning of the present year. The Postmasburg ore is, however, becoming more widely known and the development work which is at present being carried on at the mines should enable the company to derive great benefit from any general improvement in the manganese market.

Transvaal Magnesite.—The production of magnesite in the Transvaal is steadily increasing. Total sales for 1929 from all sources were 1,784 tons, valued at £3,556, while for the past year (1930) sales reached a total of £4,239. Domestic consumption accounts for all the output. There is a good prospect of establishing a market in other countries, such as South America, from which source and others enquiries have been made with a view of purchasing the Transvaal product.

PERSONAL

S. E. Birch is home from Nigeria.
A. O. Brown is leaving for Portugal.
J. T. Chappel is home from Malaya.
J. K. Coultas has been awarded the "Mavor and Coulson" travelling studentship for 1931 by the Institution of Mining Engineers.
C. H. Desch, Professor of Metallurgy in the University of Sheffield, has been appointed to succeed Dr. Rosenhain as superintendent of the metallurgy department of the National Physical Laboratory.
J. Douglas Dixon has left for South India.
H. R. Dorrington is home from Spain.
Edwin Edwards has left for West Africa.
J. L. Ford has returned to Nigeria.
F. R. H. Green is returning from Venezuela.
B. C. W. Gullachsen has left for Norway.
F. C. Hamilton is now in Holland.
W. T. Harry is returning from Malaya.
James Hocking is now in Spain.
P. M. Hume has left for the Gold Coast.
R. Underwood Jarvis has left for the Gold Coast.
C. H. Lander, Director of Fuel Research since 1923, has been appointed Professor of Engineering at the Imperial College—City and Guilds College.
B. G. Luff has left for Brazil.
A. D. Lumb is home from Sierra Leone.
Arthur E. Northey is expected shortly from Cuba.
A. V. Paull has left for Venezuela.
William J. Shephard has left for West Africa.
W. E. Sinclair is returning from the Gold Coast.
W. E. Thorne has left for Colombia.
E. A. Walker is returning from Bolivia.

G. Fitz-Brown, an Associate of the Royal School of Mines, and director of the Broughton Copper Company, died recently.

C. T. Heycock, late Goldsmiths' Reader in Metallurgy at Cambridge University, died on June 3 at the age of 72.

Alfred Wegener, best known among geologists for his continental drift theory, is presumed to have died in Greenland, having been lost in an expedition. He was in his 51st year.

TRADE PARAGRAPHS

Pulsometer Engineering Co., Ltd., of Reading, notify us that their London office has been removed to 39, Victoria Street, S.W. 1.

Societe d'Entreprises Electro-Techniques, of 35, Rue du General Foy, Paris, issue a booklet printed in French and English describing their apparatus for electrical prospecting.

Head, Wrightson, and Co., Ltd., of Stockton-on-Tees, send us catalogues devoted to elevators, belt conveyors, and screens of their manufacture and also to the improved Impact screen, which is one of the vibratory types.

G. D. Peters and Co., Ltd., of Slough, inform us that their Canadian office have received an order to the equivalent value of over £8,000 for the supply of miscellaneous stores and principally Wilson plastic arc welding equipment.

Mavor and Coulson, Ltd., of 47, Broad Street, Glasgow, send us a copy of their new catalogue devoted to Samson chain coalcutters. This covers some 45 pages and is very fully illustrated, giving details of the machine and its parts, mode of operation, and suchlike.

Edgar Allen and Co., Ltd., of Imperial Steelworks, Sheffield, issue a catalogue of their Stag single-roll crushers suitable for crushing a feed of from 10 to 12 in. in size in the small machines and up to 24 in. in size in the case of large machines for reduction to about 1½ in. cube.

American Cyanamid Co., of 535, Fifth Avenue, New York (London Agents: Cyanamid Products, Ltd., of Salisbury House, E.C. 2), have sent us a reprint of a paper presented by one of their executives at a meeting of the New York section of the A.I.M.M.E., entitled "Chemical Tools of Flotation," in which the author gives a new presentation of a fascinating subject.

E. J. Longyear Company, of Minneapolis, Minnesota, U.S.A., and **Canadian Longyear, Ltd.,** of North Bay, Ontario, Canada, announce the appointment of **Austin Hoy and Co., Ltd.,** of Bush House, London, W.C. 2, as their European distributors. This new connexion will make available from London stock Longyear diamond core drills and diamond drill supplies.

Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, advise us that Mr. W. R. Barclay, who for some years has occupied the position of managing director of Henry Wiggin and Co., Ltd., is to be consulting metallurgist to the Mond Nickel Co. Other members of the firm of Henry Wiggin and Co. are joining up with the Mond Nickel Co. as part of the scheme for closer collaboration between the two concerns.

British Engineering Standards Association, of 28, Victoria Street, London, S.W. 1, have published a standard specification for steel tub wheels and axles, both fixed-running and self-oiling, for use in mines. This shows that while there were some 3,000 types and sizes in use they are reduced in the present specification to 25.

General Electric Co., Ltd., of Magnet House, Kingsway, London, W.C. 2 (proprietors of Fraser and Chalmers Engineering Works), send us their G.E.C. Journal for May, which contains an article on the mining, smelting, and refining of copper in India, referring to the operations of the Indian Copper Corporation. This includes attractive illustrations of the general layout of the mill and mine head workings, power plant, winding engine, reduction works, refinery, and casting shop.

Bureau of Information on Nickel of the Mond Nickel Co., Ltd., of Imperial Chemical House, London, S.W. 1, have issued a further publication devoted to nickel alloy steels, which refers to the effect of nickel on heat treatment, mechanical properties, and reliability and regularity of properties, the effect of chromium with nickel, and descriptions of nickel-chromium-molybdenum and other alloy steels containing nickel, concluding with some typical properties and applications.

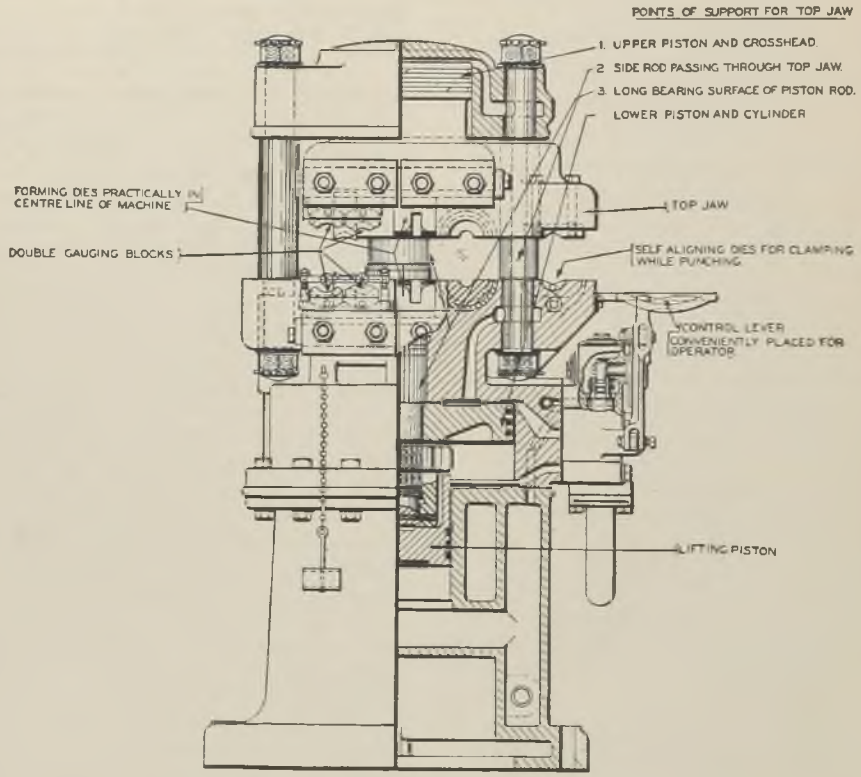
Dunford and Elliott (Sheffield), Ltd., of 54, Victoria Street, London, S.W. 1, inform us that they have purchased the goodwill and patent rights of Rotary Louvre Furnaces (System Pehrson), Ltd., and have created a special department under the management of Dr. W. R. Chapman to carry on the business of dryers, roasters, and coolers. Several large orders for dryers have recently been received, notably two from the Consolidated Mining and Smelting Co. (of Canada), Ltd., each to dry 150 tons of sulphate of ammonia per day to 0·1% of moisture.

Climax Molybdenum Co., of 295, Madison Avenue, New York, publish a handsomely prepared brochure, covering some 100 odd pages, entitled "Molybdenum in 1930." It is a sequel to similar publications in 1928 and 1929 and treats of the subject of this valuable alloy metal in its various applications, notably in high-speed steel, in aircraft construction, in nitriding, in motor-car manufacture, in special alloy steels, in alloy steel forgings, and in iron and steel castings. Details are included of analysis of molybdenum in steel and of the use of molybdenum as a catalyst.

Nor-Rust Liquid Lead Co., Ltd., of Iddesleigh House, Caxton Street, London, S.W. 1, issue a statement with regard to the means which they are offering for protection from rust. This proceeds to point out the special features which distinguish their pigment from any other on the market and claims that it forms a metallic film on iron and steel which neither scraping nor rubbing will remove. It is said, therefore, that it is impossible for rust to form underneath this film. This metallic film is, moreover, stimulated by weather and atmosphere, so that a paint coating on top of it is neither necessary nor desirable.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C.1, report that new orders have been received for the following equipment:—For England: One No. 3 "Impax" pulverizer for soap flakes, one 10-ft. Raymond separating plant for soap powder, and one No. 0 Raymond pulverizer for hydrated lime. For France: Two No. 4 "Impax" pulverizers for bituminous coal, one type 37, 2-surface, Hum-mer electric screen for cement slurry, and one type 37, 1-surface, Hum-mer electric screen for cement slurry. For Buenos Aires: One 15-ton Raymond mill for coal. For Holland: Two R.L. 13 Lopulco mills for coal. For Belgium: One 4 ft. 6 in. Raymond separator for gum arabic.

Wilfley Mining Machinery Co., Ltd., of Salisbury House, London, E.C. 2, inform us that they have been appointed London agents for Coppus Mine Blowers. These blowers have already been installed in a large number of mines in the United States and elsewhere and their use is said to be rapidly extending. They are capable of the delivery of fresh air to the working faces for tunnel driving, for reaching inaccessible places, for ventilating dead-ends or raises, for rapid advance of main-headings, for eliminating cross-cuts, for dilution and expulsion of dust-laden air or powder gases rapidly, as also for driving through old workings or reopening of old mines.



HOLMAN TWINGRIP DRILL SHARPENER.

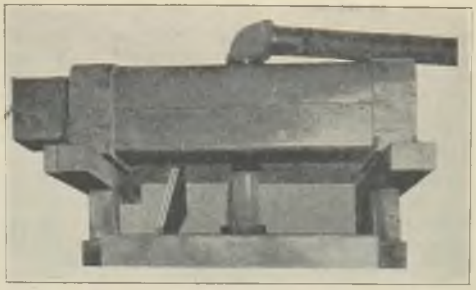
Holman Brothers, Ltd., of Camborne, Cornwall, have published a catalogue devoted to their No. 11 and No. 20 twingrip steel sharpeners. These are described as being the only sharpeners to have operating pistons both above and below the jaws, and the principal features of the No. 20 machine will be seen in the accompanying cross-sectional elevation, which shows clearly the principle of design and how the piston in the top cylinder ensures correct alignment of the jaws. The only

difference between the No. 20 and No. 11 is in capacity, the former being able to take steel up to 2¼ in. and to make bits as large as 5½ in. diameter, whilst the maximum sizes of steel and bits with which the No. 11 is capable of dealing are 1½ in. and 2¾ in. respectively. The two machines are exactly similar in design, except that self-aligning dies for clamping the steel during the punching operation are not provided for in the No. 11. Particulars of haulages for scraper loading which have also been sent to us will be given in these columns in a future issue.

British Aluminium Co., Ltd., of Adelaide House, London, E.C. 4, have issued data with regard to the principles of surface treatment of aluminium and its alloys such as are required for protection from chemical, physical, and mechanical action, for electric insulation, and other purposes. Methods are classified into two main categories — mechanical and chemical. Mechanical methods include pressure plating, polishing, spray-coating, painting and enamelling, and ornamental finishing; and chemical methods are subdivided under three main headings, (1) pure chemical, such as matting, immersion processes for colouring, metal plating, oxidizing, and miscellaneous, (2) physico-chemical, such as diffusion processes, cementation and oxidation by heating, and (3) electro-chemical processes, including anodic oxidation, electro-deposition of metals, both direct and indirect, rubber, coloured films, copper for contacts, black plates for heat absorption, and miscellaneous.

Ransomes and Rapier, Ltd., of Ipswich, have published a new catalogue devoted to their Type 420 ½ cu. yd. universal excavator, which in common with most machines of this type is convertible for use as a shovel or navvy, dragline, grab, skimmer-scoop, back-acting trencher, or crane. The catalogue describes, with illustrations and drawings, the major features of this machine and gives details of the working parts, notably the solid steel castings of which the lower frames and the crawler frames are constructed, as is also the steel of the upper frame. Another important feature includes the use of enough rollers to ensure that each complete link in the caterpillar is properly supported. The crawler frame design also tends to exclude dirt, stones, etc. The main drive from the engine is by single reduction, one pinion and one wheel with no idle gears to decrease efficiency or increase the number of wearing parts. Further particulars with regard to the main design of Ransomes and Rapier excavators were given in THE MINING MAGAZINE for January and December, 1928, and December, 1929.

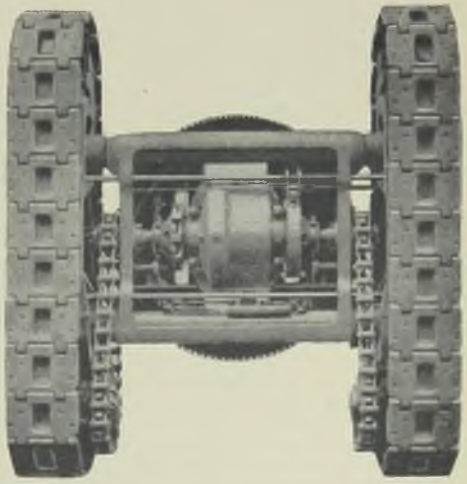
General Engineering Co., Inc., of Adelaide House, London, E.C. 4, have issued a pamphlet devoted to the Geco electric sampler, which is designed for taking accurate wet or dry samples in ore treatment processes, and comprises a motor, a speed reduction unit, and reversing switch, all within a dust-proof iron case which protects these parts from moisture and grit. This enclosed unit is again covered by the sampler case, which is made up of cast iron heads and a steel-plate body. The cutter carriage unit is mounted upon flanged wheels and rails and driven by a pinion engaging an inverted rack. A cone-shaped helical spring is mounted on the inner surface of each end to absorb the coasting action of the carriage. A steel arm projects through a slot in the carriage



GECO ELECTRIC SAMPLER.

cover from the reversing switch and is operated by lugs fastened to the sampler case, limit switches being placed at each end of the sampler case to break the circuit when the carriage has made its complete travel. The timing mechanism is driven by a Telechron motor and starts the cutter carriage unit at predetermined time intervals, the standard being 5, 10, 15, 20, 30, and 60 minutes, although any interval can be provided for. The pamphlet goes on to describe the operation of the sampler and how electric connexions control periodic movement of the sampler and there are a number of drawings included to show the general arrangement for the various classes of sampling. In a reference made in this column last month to the Genter Thickener Company omission was made of the fact that this company is controlled by the General Engineering Company.

Ruston-Bucyrus, Ltd., of Lincoln, have introduced an important modification of the caterpillar mounting of their No. 4 universal ½ yd. excavator, to which attention is directed in a recently issued pamphlet. As will be seen from the accompanying illustration, the chain drive from a single shaft has now been adopted in replacement of the earlier use of gears. They point out that the change has been made possible by the fact that the chain makers have been able to produce something strong enough to stand up to the stress and shocks involved. This chain drive is to become standard



CATERPILLAR ASSEMBLY OF RUSTON-BUCYRUS NO. 4 UNIVERSAL EXCAVATOR.

for all models up to about 50 tons in weight. The first machine to embody the new drive was the "1030," which was introduced about 12 months ago. They also send us an illustrated brochure which is descriptive of the work which has been going on continually for some years in connexion with the Sukkur Barrage on the River Indus in the Punjab. This scheme is now well on its way to completion and the work has involved the employment of 46 excavators for the removal of about 120,000,000 cu. yd. of soil, all the machines having been constructed by Ruston and Hornsby and the Bucyrus-Erie companies, which were amalgamated some time since. The 46 machines comprise a number of sizes and include 9 large excavators of 6–10 yards capacity, steam-driven, 2 steam-driven draglines of 4 yards capacity, 3 steam-driven of 3 yards capacity, 2 Diesel-electric 3 yards, 9 1½-yard Diesels, and 16 1-yard Diesels. The heaviest machines are mounted on trucks and the lighter ones on caterpillars. The brochure referred to is a valuable record of work done and includes besides descriptions of the problems encountered details of operating costs.

The Dorr Co., of New York, advise us of their union with **Oliver United Filters, Inc.** which was brought about on June 1 by the formation of a new company to be known as **Dorr-Oliver Corporation,** which will operate through its two units—a new Dorr Co. and a new United Filters. The businesses of the two uniting companies are of long standing and complementary. The Dorr Company occupies a leading position in the fields of agitation, classification, and sedimentation through its equipment, built up around the original inventions of its founder, Dr. John V. N. Dorr, and the Oliver United Filters Inc. occupies a similar position in the field of filtration through the inventions of Mr. Edwin L. Oliver and Mr. E. J. Sweetland. The union should, therefore, make it possible to offer to industry a more complete line of equipment and engineering service than either company could hope to offer individually. The growth and success of the Dorr and the Oliver United businesses have been due, to a great extent, to constructive policies of constant development and research and a broadening of fields of usefulness in anticipation of the constantly changing needs of the basic industries which they serve. Their fields are related so closely from a technical standpoint that the joint use of technical information and the projection of joint research and development is expected to result in more effective development and improvement of the equipment and processes which they have contributed to industry. Both companies have built up technical staffs and manufacturing facilities throughout the world for the pursuit of their businesses which have grown to international proportions. The common use of these established facilities should give fuller and more prompt and efficient service to clients. The two companies have frequently co-operated on the same projects and, in many instances, the equipment of both is used at different stages of operation in the same plant. The founders of both companies have enjoyed a friendship extending over almost a quarter of a century and the long acquaintance of many members of the staffs has prepared them for effective co-operative effort. Under the union of interest now effected there will be preserved to clients the close relations which they now enjoy with the respective staffs of the old organizations.

ROYAL VISIT TO HARVEY'S WORKS

The Duke of York visited the works of G. A. Harvey and Co. (London), Ltd., at Woolwich Road, London, S.E.7, on May 6. His Royal Highness there had an opportunity of seeing sheet metal work of all descriptions. Of principal interest is the work in perforated metal and in woven wire. In the former all classes of sheet metal—iron, steel, copper, brass, etc., in all thicknesses up to ¾ in.—are punched with circular or rectangular holes for screen plates and trommels and in a number of special shapes for specific purposes. In this same department

THE DUKE OF YORK INSPECTING HARVEY'S STEEL LOCKERS.

are means for rolling the punched plate either flat or in segments of a circle for trommels, the trommel being built up either by rivetting or by welding. In the woven wire department wire of any gauge is interlocked in looms which operate in a manner similar to textile weavers—i.e., a reciprocating shuttle holding a bobbin of wire which threads it between alternate transverse strands. Other woven wire screens, particularly those of coarse mesh, are made by hand, the wire being already crimped for interlocking. Another department visited is the ironwork shop, from which bunkers, oil pumps, cabinets, and such like are turned out on mass production lines, most of the joints being rapidly welded. In the zinc and copper department ventilators, chimneys, and cowls of all shapes and sizes are fashioned. The tank department is devoted to the production of all shapes and is adjoined to the galvanizing department.

Quite the hardest worked department is that engaged in the production of steel furniture, for which a new bay has been built and to which still further extensions are being made. Alongside this is a bay, which is likewise being extended,

allotted to the heavy construction department, wherein work is carried out in steel plates up to 1½ in. thickness, in copper, aluminium, stainless steel, nickel, etc. Here large storage tanks, fractionating towers, process retorts, vacuum drying plants, and many other forms of chemical engineering plant are produced. Means are available for hot pressing up to 9 ft. in diameter and for milling and planing of large metal sheets and other shapes. Gilled tubes for use in electric transformer tanks are in process of manufacture here also.

The works cover about 25 acres and give normal employment to 2,000 workpeople, for the welfare of whom adequate arrangements have been made. It was pleasing to note that all departments were in a state of active production and that the trade depression does not seem to have reached this part of London. Reproduced here is a photograph of the Duke of York inspecting steel lockers made for a colliery company in connexion with a miner's welfare scheme.

METAL MARKETS

COPPER.—The copper market exhibited further weakness during May, prices touching extraordinarily low levels. The export quotation for electro in New York was marked down to 8·75 cents, after opening the month at about 9·50 cents per lb., f.a.s. The market is undoubtedly suffering —in addition to the effects of the universal trade depression—from the results of the policy of artificial price maintenance pursued by the Copper Cartel for years past, which entailed, despite signs of an approaching economic setback a blind continuance of high production and the accumulation of unwieldy stocks. These stocks are now hanging over the market menacingly and, although pretty firmly held, they necessarily add to the distrust with which buyers regard the position. American industry, which is such an important copper consumer, still languishes and the European financial and commercial situation is so gloomy that it seems hopeless to look for any immediate substantial improvement in world consuming demand.

Average price of cash standard copper: May, 1931, £38 18s. 10d.; April, 1931, £42 14s. 8d.; May, 1930, £53 5s.; April, 1930, £62 3s. 3d.

TIN.—Despite the decision of the International Tin Committee to recommend a further "cut" in output to the extent of some 20,000 tons annually, sentiment on the London market remained "bearish" during May and prices receded towards the £100 level after slight temporary firmness about the middle of the month. An uneasy feeling is in evidence that even the increased rate of output-curtailment—which incidentally has been recommended before the full effects of the original "cut" have had time to show themselves—may not be adequate to restore equilibrium between supply and demand, let alone to effect the hoped-for reduction in world visible supplies which, by the way, increased by a further 3,000 tons during the month just ended. Failing definite proof that the efforts of producers to adjust output to consumption are going to be successful, or that world trade conditions generally are on the mend, the outlook for the market is likely to remain somewhat doubtful.

Average price of cash standard tin: May, 1931, £104 8s.; April, 1931, £112 16s. 9d.; May, 1930, £144 18s.; April, 1930, £162 14s. 7d.

LEAD.—This market kept moderately steady during the past month until the close, when weakness definitely developed. The position has not yet been improved by the joint curtailment of output by producers and meanwhile the market is threatened with fresh supplies from the big Mount Isa properties in Australia which are now starting operations. Consuming demand has remained restricted and apart from the comparative cheapness of the price and the fact that the majority of producers are working in some sort of co-operative fashion which may be tightened up if necessary, there are really very few encouraging factors in the position. In view, however, of the low quotation, it is somewhat difficult to see how it can fall very much further.

Average mean price of soft foreign lead: May, 1931, £11 12s. 8d.; April, 1931, £12 9s. 9d.; May, 1930, £17 16s. 6d.; April, 1930, £18 6s. 9d.

SPELTER.—Prices moved within a narrow compass during May, but the undertone was rather easy on the whole. This cannot be regarded as surprising as the situation of the spelter producing and consuming industries has continued to be most unsatisfactory. Probably if prices were not already down to extraordinary low levels we should witness a further decline, but as a matter of fact very few works can produce at anything resembling a satisfactory profit at current market values, and the gradual closure of smelters on the Continent is a sign that a number of works are being squeezed out of production, at least for the time being. Eventually, the curtailment of output enforced by economic conditions should tend to restore the market to a healthier state, but it may be a painful and protracted process.

Average mean price of spelter: May, 1931, £10 13s. 7d.; April, 1931, £11 11s. 10d.; May, 1930, £16 19s. 8d.; April, 1930, £18 1s. 11d.

IRON AND STEEL.—May was by no means a propitious month for the British blast furnaces. Cleveland makers of pig-iron were faced with a subdued home demand, very little export interest, and insistent foreign competition, but were disinclined to make price concessions in an effort to attract fresh buying. In the Midlands, however, the blast furnaces announced a "cut" of from 2s. 6d. to 5s. per ton, but business is so dead that they do not seem to have benefited very appreciably from this step. Cleveland No. 3 foundry g.m.b. remained unaltered at 58s. 6d. Hematite was an easy though fairly active market, East Coast Mixed Numbers being priced at the close of the month at about 65s. per ton or less. The finished steel market, both as regards British and Continental material, remained deadly dull, the almost complete stagnation of the British shipbuilding industry being a severe blow to the mills in this country.

IRON ORE.—There has been no improvement in the position of this market. Business has been at a standstill with the exception of a few cargoes of best Bilbao rubio, which have changed hands at about 15s. per ton c.i.f., although with easier freights 14s. 9d. might now be accepted.

ANTIMONY.—At the close of May English regulus was quoted at from about £35 up to £42 10s. per ton. There was only a dull demand for Chinese regulus, with spot material priced at about £23 to £23 10s. ex warehouse and metal for shipment from China at about £19 15s. c.i.f.

ARSENIC.—There is now practically no Cornish arsenic offering owing to the trivial output of tin

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.		Cash.			3 Months.			Soft Foreign.		English.		Cash.	Forward.	
	Cash.			3 Months.																	
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.	d.	s. d.
May																								
12	39	15	7½	40	10	7½	43	10	0	41	0	0	104	6	3	105	13	9	10	10	0	11	11	3	13	0	0	13⅛	13 1/16	84 9½
13	38	19	4½	39	14	4½	42	10	0		—		104	12	6	105	18	9	10	5	0	11	7	6	12	15	0	13⅛	13⅛	84 10½
14	39	1	3	39	13	1½	43	10	0		—		105	1	3	106	6	3	10	6	3	11	7	6	12	15	0	13 1/16	13⅛	84 11½
15	39	8	9	40	1	10½	43	10	0	40	12	6	105	8	9	106	13	9	10	16	3	11	10	0	12	15	0	13 1/16	13	84 11¼
18	39	4	4½	39	16	10½	42	10	0		—		109	13	9	110	18	9	10	15	0	11	12	6	13	0	0	12⅞	12 13/16	84 11½
19	38	18	9	39	9	4½	42	10	0	40	5	0	106	18	9	108	6	3	10	10	0	11	10	0	13	0	0	12 7/16	12⅞	84 9¼
20	38	15	0	39	6	10½	42	5	0		—		105	1	3	106	8	9	10	7	6	11	11	3	13	0	0	12⅞	12 7/16	84 9⅜
21	37	16	10½	38	9	4½	42	0	0		—		103	6	3	104	13	9	10	7	6	11	10	0	13	0	0	12 13/16	12⅛	84 9⅜
22	37	6	10½	38	0	10½	41	10	0	38	12	6	104	13	9	106	1	3	10	8	9	11	8	9	13	0	0	12⅞	12⅛	84 9⅛
26	37	17	6	38	9	4½	41	10	0	39	0	0	102	3	9	103	11	3	10	12	6	11	7	6	13	0	0	12⅛	12 7/16	84 11
27	37	5	0	37	18	1½	41	0	0		—		102	11	3	104	1	3	10	8	9	11	6	3	13	0	0	12⅜	12 7/16	84 9⅛
28	36	16	10½	37	10	7½	40	5	0		—		101	8	9	102	18	9	10	6	3	11	0	0	12	10	0	12 7/16	12⅛	84 11
29	36	3	1½	36	16	10½	40	5	0	36	17	6	100	13	9	102	3	9	10	0	0	10	12	6	12	5	0	12⅛	12⅛	84 9½
June																								
1	35	16	10½	36	10	7½	40	5	0		—		100	13	9	102	3	9	9	18	9	10	16	3	12	5	0	12⅛	12⅛	84 9½
2	35	1	10½	35	16	3	39	10	0	36	5	0	100	13	9	102	2	6	9	16	3	10	13	9	12	5	0	12⅜	12⅜	84 10½
3	34	8	9	35	2	6	39	10	0		—		100	8	9	102	1	3	9	15	0	10	7	6	12	0	0	12 7/16	12⅛	84 10¼
4	34	1	3	34	13	9	38	10	0		—		100	6	3	102	1	3	9	13	9	10	7	6	12	0	0	12 7/16	12¼	84 11⅜
5	35	8	9	36	1	3	38	10	0	36	5	0	100	11	3	102	3	9	9	18	9	10	16	3	12	5	0	12⅛	12⅛	84 11⅜
8	34	10	7½	35	5	7½	38	10	0		—		100	13	9	102	3	9	10	0	0	10	12	6	12	0	0	12⅜	12⅜	84 11⅜
9	35	5	0	36	0	0	38	10	0	36	5	0	100	16	3	102	8	9	10	5	0	10	17	6	12	5	0	12 7/16	12 7/16	84 11⅛
10	35	4	4½	35	18	1½	38	10	0		—		103	3	9	104	13	9	10	17	6	11	6	3	12	15	0	12⅜	12⅜	84 11½

there. Mexican high grade, however, is still quoted at £17 10s. per ton c.i.f. Liverpool.

Bismuth.—A fair demand is maintained and the official price was advanced during May to 5s. 6d. per lb. for 5 cwt. lots and over.

Cadmium.—About 1s. 9⅛d. to 1s. 10⅛d. per lb. still represents the current value, demand remaining very moderate.

Cobalt Metal.—Officially the price remains at 10s. per lb., but the usual rebates are made for contracts.

Cobalt Oxides.—Black oxide is selling at about 4s. 9d. to 5s. 3d. per lb. and grey at about 6s. 3d. to 6s. 6d., competition being keen.

Chromium Metal.—Current quotations are about 2s. 5d. to 2s. 6d. per lb. delivered.

Tantalum.—Demand for this metal is practically non-existent, and prices are quite nominal at between £40 and £50 per lb.

Platinum.—Irregular conditions prevailed in this market during May, but towards the end of the month the tone was noticeably firmer and quotations advanced at £5 2s. 6d. to £5 7s. 6d. per oz.

Palladium.—The market has been quietly steady, with prices unchanged at £3 12s. 6d. to £4 per oz.

Iridium.—Demand has been trifling and prices have eased to about £20 per oz. for sponge and powder, but even at the lower level buyers are showing no interest.

Osmium.—A moderate enquiry continues at about £13 to £14 per oz.

Tellurium.—Somewhere about 9s. 6d. per lb. is named for this metal, but there is nothing moving at the moment.

Selenium.—A fair business is passing at 7s. 8d. to 7s. 9d. per lb. ex warehouse, Liverpool.

Manganese Ore.—No improvement can be reported in this market, and no sales of any consequence have been made for weeks past. Prices are nominal in the region of 1s. per unit c.i.f. for best Indian, 10½d. for good 48% Indian and 10d. to 10½d. c.i.f. for washed Caucasian.

Aluminium.—No change was made in prices at the meeting of European producers last month, but demand is very slow and stocks are said to be accumulating despite the curtailed rate of output. Prices remain at £85, less 2%, for ingots and bars.

Sulphate of Copper.—British material is still quoted at £21 to £21 10s. per ton, less 5%.

Nickel.—Leading producers are operating at about 50% of capacity, which is said to be slightly below the present rate of consumption. Prices are unaltered at £170 to £175 per ton, according to quality.

Chrome Ore.—Demand has been diminishing recently and prices are easier at about 75s. to 77s. 6d. per ton c.i.f. for good 48% Rhodesian ore.

Quicksilver.—After pegging prices for about three years, Mercurio Europeo, the Italo-Spanish consortium's sales agency, reduced prices by £5 per bottle to £16 15s. f.o.b. on June 1, this price being net. It remains to be seen whether demand will be appreciably stimulated by this movement.

Tungsten Ore.—Buying interest has absolutely dried up and no sales of any importance have been heard of for some weeks. Prices are now in the neighbourhood of 12s. 6d. to 13s per unit c.i.f. for forward shipment.

Molybdenum Ore.—Although some leading sellers are still asking about 35s. per unit c.i.f. odd lots have been changing hands at much lower figures, down to about 29s. having been accepted.

Graphite.—Demand continues very slow and prices have eased to about £13 per ton c.i.f. for 85 to 90% raw Madagascar flake, and £14 to £15 c.i.f. for 90% Ceylon lumps.

Silver.—On May 1 spot bars stood at 13d. per oz., and with some small buying interest by India and China prices improved to 13¼d. by May 7, but by May 16 had slipped back to 13d. again. During the latter half of May both India and China were rather inclined to sell and America continued to offer, with the result that prices broke rather sharply, falling to 12⅛d. for spot bars on May 29, but recovering slightly to 12 3/16d. on May 30. Much talk is still heard about a possible international conference with a view to improving the position of silver producers, but nothing tangible has yet been done to call such a meeting.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
May, 1930	876,893	39,320	916,213
June	847,952	40,515	887,867
July	871,468	41,184	912,652
August	878,474	42,607	921,081
September	860,311	42,865	903,176
October	884,612	41,949	926,561
November	844,038	40,715	884,753
December	867,302	41,200	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937
March	869,331	41,667	910,998
April	840,259	42,078	882,337
May	867,949	42,330	910,279

TRANSVAAL GOLD OUTPUTS.

	April.		May.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	90,000	£139,041	96,000	£145,211
City Deep	88,000	23,104	91,000	23,203
Cons. Main Reef	64,000	21,930	67,500	22,296
Crown Mines	241,000	79,045	268,000	83,607
D'rb'n Roodepoort Deep	46,300	14,963	47,800	15,411
East Rand P.M.	149,500	40,793	158,000	43,027
Geduld	81,000	26,063	86,000	27,428
Geldenhuis Deep	70,500	16,034	71,700	16,323
Glynn's Lydenburg	6,200	2,364	6,300	2,043
Government G.M. Areas	196,000	£388,027	205,000	£401,211
Kleinfontein	50,700	10,027	52,100	10,417
Langlaagte Estate	76,000	£113,736	78,000	£113,470
Luipaard's Vlei	29,300	7,431	31,500	7,870
Meyer and Charlton	17,800	£18,221	18,300	£18,632
Modderfontein New	157,000	67,707	166,000	68,595
Modderfontein B	72,000	21,362	77,000	22,503
Modderfontein Deep	43,500	22,107	44,200	22,488
Modderfontein East	70,500	21,125	72,500	21,748
New State Areas	77,000	£166,812	80,000	£171,230
Nourse	66,000	20,129	70,000	21,108
Randfontein	213,000	£246,955	235,000	£265,762
Robinson Deep	92,000	27,221	99,000	27,538
Rose Deep	60,000	12,299	63,700	12,782
Simmer and Jack	71,900	21,768	83,000	22,776
Springs	67,500	£144,278	71,400	£149,944
Sub Nigel	32,000	28,108	33,200	28,894
Transvaal G.M. Estates	15,500	5,002	16,000	5,154
Van Ryn	43,000	£41,881	44,000	£93,238
Van Ryn Deep	59,000	£92,403	61,000	£42,764
West Rand Consolidated	91,000	£106,991	94,500	£109,891
West Springs	64,500	£70,473	70,500	£74,856
Witw'tersr'nd (Knights)	54,000	£48,891	62,000	£51,321
Witwatersrand Deep	37,100	11,754	31,200	11,383

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.	£
February, 1930	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,250	28 7	20 1	8 6	1,084,504
May	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	2,481,600	28 6	20 1	8 5	1,045,980
March	2,718,400	28 2	19 9	8 5	1,151,017
April	—	—	—	—	1,105,711

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
May 31, 1930	202,182	15,028	5,340	222,550
June 30	201,324	14,948	5,126	221,398
July 31	201,111	14,670	5,490	221,271
August 31	202,257	14,788	5,754	222,799
September 30	205,061	14,706	5,767	225,534
October 31	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781
April 30	206,770	13,242	4,030	224,042
May 31	207,109	13,305	3,689	224,103

PRODUCTION OF GOLD IN RHODESIA.

	1928	1929	1930	1931
	oz.	oz.	oz.	oz.
January	51,356	46,231	46,121	45,677
February	46,286	44,551	43,385	42,818
March	48,017	47,388	45,511	42,278
April	48,549	48,210	45,806	43,776
May	47,323	48,189	47,645	—
June	51,762	48,406	45,208	—
July	48,960	46,369	45,810	—
August	50,611	46,473	46,152	—
September	47,716	45,025	46,151	—
October	43,056	46,923	45,006	—
November	47,705	46,219	44,351	—
December	44,772	46,829	46,485	—

RHODESIAN GOLD OUTPUTS.

	April.		May.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,600	10,363	24,800	10,230
Globe and Phœnix	6,028	5,307	6,010	5,316
Lonely Reef	6,400	2,324	6,700	3,142
Luiri Gold	1,618	£2,500	1,646	£2,892
Rezende	6,400	2,653	6,400	2,639
Sherwood Star	4,600	£9,803	4,700	£8,978
Wanderer Consolidated	15,000	3,694	15,300	3,660

WEST AFRICAN GOLD OUTPUTS.

	April.		May.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	4,350	£7,975	4,442	£9,069
Ashanti Goldfields	11,900	14,044	12,063	14,222
Taquah and Abosso	10,310	£16,209	10,090	£15,544

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
May, 1930	32,967	3,480	580
June	41,738	812	673
July	34,174	2,327	728
August	38,579	1,864	323
September	32,034	1,992	429
October	39,687	1,685	628
November	33,708	2,174	436
December	42,097	3,105	260
January, 1931	27,306	—	405
February	38,370	—	458
March	34,946	—	—
April	38,891	—	—
May	38,255	—	—

AUSTRALASIAN GOLD OUTPUTS.

	April.		May.	
	Tons	Value £	Tons.	Value £
Associated G.M. (W.A.)	4,898	7,919	4,948	7,008
Blackwater (N.Z.)	3,460	4,993	4,157	7,274
Boulder Persev'ce (W.A.)	6,700	14,301	7,187	15,301
Grt. Boulder Pro. (W.A.)	10,058	25,668	11,360	26,792
Lake View & Star (W.A.)	8,744	21,585	—	—
Sons of Gwalia (W.A.)	12,024	14,688	12,508	14,731
South Kalgurli (W.A.)	8,246	14,516	8,437	16,048
Waihi (N.Z.)	16,898	5,850* 19,635†	—	— —

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	April.		May.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,350	2,109	3,750	2,108
Champion Reef	8,100	5,455	8,375	5,284
Mysore	15,571	7,704	12,360	6,010
Nundydroog	12,639	7,282	12,004	6,947
Ooregum	12,000	4,607	10,000	4,863

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	April.		May.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	9,430	14,000	9,670	13,580
Frontino & Bolivia (C'lbia)	2,150	10,535	3,700	16,638†
Marmajito (Colombia)	980	4,263	—	—
Fresnillo	89,327	3,268	—	—
New Goldfields of Venezuela	4,844	1,890*	5,197	1,524*
Oriental Cons. (Korea)	16,621	111,256*d*	—	98,740*d*
St. John del Rey (Brazil)	—	35,500	—	45,000
Santa Gertrudis (Mexico)	—	—	—	—
West Mexican Mines	1,740	25,000*d*	—	—

d Dollars. * Oz. gold. † Includes Marmajito output.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1930	5,525	January, 1931	5,450
August	4,153	February	5,470
September	4,048	March	4,461
October	4,807	April	4,510
November	4,812	May	—
December	5,019	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Mar.	Apr.	May
Ayer Hitam	107½	131	89½
Batu Caves	2½	18	17½
Changkat	40	55	50
Gopeng	59½	59½	59½
Hongkong Tin	50½	107	98
Idris Hydraulic	20½	22	27½
Ipoh	37½	36	29½
Kampar Malaya	67	83	70½
Kampong Lanjut	82	84	74
Kamunting	152½	194	266
Kent (F.M.S.)	28	28	18
Kinta	22½	22½	22
Kinta Kellas	68½	37½	39½
Kramat Tin	75	85	85
Kuala Kampar	42	77	68
Kundang	8	14	16
Lahat	20½	18	20½
Lower Perak	—	—	89
Malaya Consolidated	63	42½	34½
Malayan Tin	131	137	154½
Malim Nawar	18	30	29
Pahang	255½	221½	180
Penawat	69½	83½	101½
Pengkalen	65½	65½	62½
Petaling	176	133	176
Rahman	65½	89½	95½
Rambutan	9½	9½	12
Rantau	22	29	33
Rawang	65	65	68
Rawang Concessions	40	45	70
Renong	63½	32	31
Selayang	—	17	24
Southern Malayan	163½	190½	172½
Southern Perak	35½	53½	64½
Southern Tronoh	45	54	72
Sungei Besi	42	42	—
Sungei Kinta	38½	35½	31½
Sungei Way	119	119	131
Taiping	23	33	35
Tanjong	44½	35½	44½
Teja Malaya	26½	30	24½
Tekka	33	37½	34½
Tekka-Taiping	57½	62	48
Temengor	11½	—	—
Temoh	41	37½	53½
Tronoh	93	84	87
Ulu Klang	26½	34	53

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Mar.	Apr.	May
Amari	—	—	—
Anglo-Nigerian	58	48	42½
Associated Tin Mines	220	200	259
Baba River	7	7	—
Batura Monguna	5	—	—
Bisichi	49	40	—
Daffo	6	—	—
Ex-Lands	—	52	59½
Filani	2½	2½	4½
Jantar	21	22	22
Jos	20	12	—
Juga Valley	5	8	7
Kaduna Syndicate	25	30	
Kaduna Prospectors	7	10	—
Kassa	12½	12	10
London Tin	220	130	196
Lower Bisichi	—	5½	—
Naraguta	21	14½	—
Naraguta Durumi	7	4½	—
Naraguta Extended	10	10	9½
Naraguta Karama	21½	14	—
Naraguta Korot	10½	9	—
Nigerian Consolidated	14	12	—
Offin River	3½	4½	3½
Ribon Valley	8	6½	18
South Bukeru Areas	11	8	—
Tin Fields	4½	5½	3½
Tin Properties	—	—	—
United Tin Areas	18	18	20½
Yarde Kerri	—	—	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Mar.	Apr.	May
Anglo-Burma (Burma)	15½	15	11
Aramayo Mines (Bolivia)	198	214	217
Bangrin (Siam)	82½	78	76
Beralt	—	38*	30*
Consolidated Tin Mines (Burma)	90	92	82
East Pool (Cornwall)	43½	44½	45½
Fabulosa (Bolivia)	115½	86½	69
Geevor (Cornwall)	—	—	—
Kagera (Uganda)	20	20	7
Kamra	48½	41½	—
Malaysiam Tin	28½	21	17
Mawchi	312*	303*	—
Patino	1,416	1,344	—
Pattani	47½	49	—
Rooiberg Minerals	27	34	—
San Finx (Spain)	27½*	—	—
Siamese Tin (Siam)	188½	185	200½
Tavoy Tin (Burma)	61	46½	33
Tongkah Harbour (Siam)	70	75	70
Toyo (Japan)	64½	50	66
Zaaiplaats	20½	15	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Apr.	May
Broken Hill South	Tons lead conc.	4,907	4,481
	Tons zinc conc.	2,435	4,503
Burma Corporation	Tons refined lead	6,700	5,880
	Oz. refined silver	530,000	470,400
Electrolytic Zinc	Tons zinc	4,175	4,183
Indian Copper	Tons copper	346	350
Messina	Tons copper	683	775
Mount Lyell	Tons concentrates	3,014	2,803*
North Broken Hill	Tons lead conc.	4,930	—
	Tons zinc conc.	1,940	—
Poderosa	Tons copper ore	392	—
Rhodesia Broken Hill	Tons V_2O_5	15	18
	Tons slab zinc	1,010	1,015
San Francisco Mexico	Tons lead conc.	3,588	3,691
	Tons zinc conc.	3,585	4,251
Tetiuhe	Tons lead conc.	735	944
	Tons zinc conc.	1,815	2,441
Trepca	Tons lead conc.	3,129	3,136
	Tons zinc conc.	2,643	2,839
Zinc Corporation	Tons lead conc.	5,591	4,334
	Tons zinc conc.	4,058	3,614

* To May 20.

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

		March.	April.
Iron Ore	Tons	211,441	184,255
Manganese Ore	Tons	4,835	7,804
Iron and Steel	Tons	210,467	193,390
Copper and Iron Pyrites	Tons	21,428	20,880
Copper Ore, Matte, and Prec.	Tons	3,239	2,414
Copper Metal	Tons	11,985	15,891
Tin Concentrate	Tons	3,227	5,763
Tin Metal	Tons	1,680	902
Lead Pig and Sheet	Tons	21,792	36,400
Zinc (Spelter)	Tons	15,178	15,322
Zinc Sheets, etc.	Tons	1,536	1,341
Aluminium	Tons	2,703	1,692
Mercury	Lb.	80,343	96,900
Zinc Oxide	Tons	734	640
White Lead	Cwt.	11,426	11,238
Red and Orange Lead	Cwt.	3,393	934
Barytes, ground	Cwt.	43,618	35,689
Asbestos	Tons	1,621	1,146
Boron Minerals	Tons	654	1,165
Borax	Cwt.	24,999	15,725
Basic Slag	Tons	4,106	1,510
Superphosphates	Tons	22,843	22,319
Phosphate of Lime	Tons	32,323	7,882
Mica	Tons	252	133
Sulphur	Tons	8,642	510
Nitrate of Soda	Cwt.	51,572	169,362
Potash Salts	Cwt.	369,023	363,114
Petroleum : Crude	Gallons	33,403,763	41,471,482
Lamp Oil	Gallons	21,934,514	20,137,724
Motor Spirit	Gallons	96,975,648	69,756,321
Lubricating Oil	Gallons	7,487,620	8,175,601
Gas Oil	Gallons	6,619,568	9,736,177
Fuel Oil	Gallons	41,627,720	33,994,593
Asphalt and Bitumen	Tons	18,696	10,463
Paraffin Wax	Cwt.	98,991	102,144
Turpentine	Cwt.	8,691	22,756

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	March.	April.	May.
Anglo-Ecuadorian	15,541	16,824	20,505
Apex Trinidad	45,930	48,080	47,640
Attock	1,619	1,542	1,628
British Burmah	4,559	4,299	4,336
British Controlled	36,043	36,416	39,274
Kern Mex	815	898	1,027
Kern River (Cal.)	1,790	2,027	2,499
Kern Romana	1,140	1,015	741
Kern Trinidad	5,626	4,898	5,078
Lobitos	25,418	24,767	25,684
Phœnix	61,249	67,936	66,418
St. Helen's Petroleum	5,921	5,418	4,930
Steaua Romana	85,710	73,670	83,040
Tampico	3,209	2,940	2,857
Tocuyo	2,348	2,396	2,556
Trinidad Leaseholds	20,050	13,650	14,650

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	May 11, 1931.			June 10, 1931.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		6	0		6	3
Anglo-Egyptian B.	1	15	0	1	7	6
Anglo-Persian 1st Pref.	1	5	6	1	6	9
" " Ord.	1	15	0	1	18	0
Apex Trinidad (5s.)		8	9		6	6
Attock		12	6		11	3
British Burmah (8s.)		3	9		4	0
British Controlled ($5)		1	3		1	3
Burmah Oil	2	10	0	2	6	9
Kern River Cal. (10s.)		1	6		1	3
Lobitos, Peru		16	3	1	0	0
Mexican Eagle, Ord. (4 pesos)		6	9		6	9
" " 8% Pref. (4 pesos)		7	0		7	3
Phœnix, Roumanian		4	9		3	9
Royal Dutch (100 fl.)	19	10	0	16	12	6
Shell Transport, Ord.	2	13	0	2	5	0
" " 5% Pref. (£10)	10	0	0	10	0	0
Steaua Romana		3	9		3	3
Trinidad Leaseholds		13	9		15	0
United British of Trinidad (6s. 8d.)		3	9		3	3
V.O.C. Holding	1	9	3	1	9	3

PRICES OF CHEMICALS. June 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		18	9
" 80%	"	1	16	3
" Glacial	per ton	58	0	0
Alum	"	8	7	6
Aluminium Sulphate, 17 to 18%	"	6	15	0
Ammonium, Anhydrous	per lb.			11
" 0·880 solution	per ton	15	10	0
" Carbonate	"	27	10	0
" Nitrate (British)	"	16	0	0
" Phosphate, comml.	"	40	0	0
" Sulphate, 20·6% N.	"	9	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
" Sulphide, golden	"			9
Arsenic, White	per ton	19	7	6
Barium, Carbonate, 94%	"	4	10	0
" Chloride	"	8	15	0
" Sulphate, 94%	"	6	5	0
Benzol, standard motor	per gal.		1	5
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	"	13	10	0
Boric Acid	"	22	0	0
Calcium Chloride, solid, 70/75%	"	5	5	0
Carbolic Acid, crude 60's	per gal.		1	1½
" " crystallized, 40°	per lb.			5⅜
Carbon Disulphide	per ton	16	10	0
Citric Acid	per lb.			11½
Copper Sulphate	per ton	18	15	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4½
Cresylic Acid, 98-100%	"		1	8
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per oz.		1	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
" Sulphate	"	2	2	6
Lead, Acetate, white	"	32	7	6
" Nitrate (ton lots)	"	28	15	0
" Oxide, Litharge	"	26	10	0
" White	"	36	10	0
Lime, Acetate, brown	"	7	5	0
" " grey, 80%	"	12	0	0
Magnesite, Calcined	"	9	10	0
Magnesium, Chloride	"	5	10	0
" Sulphate, comml.	"	3	15	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	1
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	1	14	0
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	"	42	10	0
Potassium Bichromate	per lb.			4½
" Carbonate, 96/98%	per ton	24	0	0
" Chlorate	"	27	10	0
" Chloride 80%	"	9	5	0
" Ethyl Xanthate	per 1,016 kilos	55	15	0
" Hydrate (Caustic) 88/90%	per ton	28	10	0
" Nitrate	"	19	17	6
" Permanganate	per lb.			5¾
" Prussiate, Yellow	"			6¾
" " Red	"		1	8
" Sulphate, 90%	per ton	10	10	0
Sodium Acetate	"	17	0	0
" Arsenate, 45%	"	20	10	0
" Bicarbonate	"	10	10	0
" Bichromate	per lb.			3½
" Carbonate (Soda Ash) 58%	per ton	6	0	0
" " (Crystals)	"	5	5	0
" Chlorate	"	26	5	0
" Cyanide. 100% NaCN basis	per lb.			7
" Ethyl Xanthate	per 1,016 kilos	53	5	0
" Hydrate, 76%	per ton	14	10	0
" Hyposulphite, comml.	"	9	2	6
" Nitrate (ordinary)	"	10	0	0
" Phosphate, comml.	"	10	0	0
" Prussiate	per lb.			4¾
" Silicate	per ton	9	10	0
" " (liquid, 140° Tw.)	"	8	10	0
" Sulphate (Glauber's Salt)	"	2	15	0
" " (Salt-Cake)	"	2	17	6
" Sulphide Conc., 60/65%	"	8	15	0
" Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	9	5	0
" Roll	"	6	5	0
Sulphuric Acid, 168° Tw.	"	4	5	0
" " free from Arsenic, 140° Tw.	"	3	0	0
Superphosphate of Lime (S.P.A. 16%)	"	3	9	0
Tartaric Acid	per lb.			11½
Turpentine	per ton	50	0	0
Tin Crystals	per lb.			10½
Titanous Chloride	"			10
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	"	20	0	0
Zinc Oxide (White Seal)	"	35	0	0
Zinc Sulphate	"	8	5	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	May 11, 1931. £ s. d.	June 10, 1931. £ s. d.
SOUTH AFRICA:		
Brakpan	2 17 6	2 18 9
City Deep	4 6	3 9
Consolidated Main Reef	1 1 0	1 0 6
Crown Mines (10s.)	4 2 6	4 7 0
Daggafontein	2 2 6	2 2 6
Durban Roodepoort Deep (10s.)	16 0	15 9
East Geduld	2 13 0	2 13 0
East Rand Proprietary (10s.)	11 6	11 0
Geduld	3 18 0	4 1 0
Geldhenhuis Deep	8 0	8 3
Glynn's Lydenburg	4 9	5 0
Government Gold Mining Areas (5s.)	1 12 6	1 13 0
Langlaagte Estate	1 4 0	1 5 6
Meyer & Charlton	15 0	18 0
Modderfontein New (10s.)	3 5 0	3 5 9
Modderfontein B (5s.)	10 6	10 6
Modderfontein Deep (5s.)	1 1 3	1 2 0
Modderfontein East	1 12 6	1 12 0
New State Areas	2 2 0	2 3 9
Nourse	13 0	14 0
Randfontein	1 0 0	1 1 0
Robinson Deep A (1s.)	15 0	16 3
" " B (7s. 6d.)	11 0	10 0
Rose Deep	5 3	4 9
Simmer & Jack (2s. 6d.)	3 0	3 0
Springs	3 1 0	3 3 9
Sub Nigel (10s.)	2 18 0	3 0 6
Van Ryn	8 3	8 6
Van Ryn Deep	1 5 9	1 5 6
Village Deep (9s. 6d.)	6 3	2 3
West Rand Consolidated (10s.)	10 0	9 6
West Springs	11 3	10 9
Witwatersrand (Knight's)	9 0	8 0
Witwatersrand Deep	3 9	3 6
RHODESIA:		
Cam and Motor	18 0	17 6
Gaika	3 6	3 6
Globe and Phœnix (5s.)	13 0	13 0
Lonely Reef	15 0	16 9
Mayfair	3 9	4 3
Rezende	1 1 9	1 0 0
Shamva	1 0	1 0
Sherwood Starr (5s.)	14 3	13 9
GOLD COAST:		
Ashanti (4s.)	1 5 9	1 10 0
Taquah and Abosso (5s.)	4 3	4 3
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 4	2 3
Great Boulder Propriet'y (2s.), W.A.	1 3	1 0
Lake View and Star (4s.), W.A.	9 6	8 6
Sons of Gwalia, W.A.	4 3	3 6
South Kalgurli (10s.), W.A.	11 6	11 6
Waihi (5s.), N.Z.	13 6	12 6
Wiluna Gold, W.A.	16 9	13 9
INDIA:		
Balaghat (10s.)	2 0	2 0
Champion Reef (10s.)	6 6	5 6
Mysore (10s.)	7 3	6 9
Nundydroog (10s.)	15 6	14 9
Ooregum (10s.)	3 0	2 9
AMERICA:		
Camp Bird (2s.), Colorado	6	3
Exploration (10s.)	3 0	1 6
Frontino and Bolivia, Colombia	10 6	10 6
Mexican Corporation, Mexico (10s.)	4 0	3 0
Mexico Mines of El Oro, Mexico	1 6	1 6
Panama Corporation	14 3	14 0
St. John del Rey, Brazil	1 9 0	18 0
Santa Gertrudis, Mexico	6 6	5 9
Selukwe (2s. 6d.), British Columbia	2 3	1 9
MISCELLANEOUS:		
Chosen, Korea	4 6	3 9
Lena Goldfields, Russia	6	6
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	3 6	3 6
Esperanza Copper	13 9	13 9
Indian (2s.)	1 3	1 3
Loangwa (5s.), Rhodesia	1 0	1 0
Luiri (5s.), Rhodesia	2 6	9
Messina (5s.), Transvaal	8 6	6 3
Mount Lyell, Tasmania	15 0	14 6
Namaqua (£2), Cape Province	6 3	6 3
N'Changa, Rhodesia	1 15 0	1 15 0
Rhodesia-Katanga	15 0	12 6
Rio Tinto (£5), Spain	19 15 0	16 7 6
Roan Antelope (5s.), Rhodesia	13 9	10 6
Tanganyika Con.	1 3 9	19 6
Tharsis (£2), Spain	2 14 0	2 3 9

LEAD-ZINC:	May 11, 1931. £ s. d.	June 10, 1931. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	10 0	9 0
Broken Hill, North, N.S.W.	1 12 6	1 12 6
Broken Hill South, N.S.W.	1 5 0	1 2 6
Burma Corporation (10 rupees)	6 9	5 6
Electrolytic Zinc Pref., Tasmania	15 0	13 9
Mount Isa, Queensland	10 0	7 0
Rhodesia Broken Hill (5s.)	1 0	1 0
San Francisco (10s.), Mexico	10 6	8 0
Sulphide Corporation (15s.), N.S.W	4 6	4 0
ditto, Pref.	8 6	7 0
Zinc Corporation (10s.), N.S.W.	13 9	12 6
ditto, Pref.	2 6 3	2 12 6
TIN:		
Aramayo Mines (25 fr.), Bolivia	1 1 3	18 9
Associated Tin (5s.), Nigeria	3 9	4 3
Ayer Hitam (5s.)	11 0	10 6
Bangrin, Siam	11 6	8 9
Bisichi (10s.), Nigeria	4 9	4 9
Chenderiang, Malay	1 6	1 6
Consolidated Tin Mines of Burma	2 6	1 6
East Pool (5s.), Cornwall	6	6
Ex-Lands Nigeria (2s.), Nigeria	1 6	1 6
Geevor (10s.), Cornwall	3 0	2 9
Gopeng, Malaya	1 15 0	1 15 0
Hongkong (5s.)	15 3	14 6
Idris (5s.), Malava	6 6	6 3
Ipoh Dredging (10s.), Malay	14 0	13 6
Kaduna Prospectors (5s.), Nigeria	5 9	4 6
Kaduna Syndicate (5s.), Nigeria	12 6	12 6
Kamunting (5s.), Malay	4 6	3 6
Kepong, Malay	10 0	10 0
Kinta, Malay (5s.)	6 6	6 6
Kinta Kellas, Malay (5s.)	5 6	5 0
Kramat Pulai, Malay	1 0 0	18 9
Lahat, Malay	5 3	5 3
Malayan Tin Dredging (5s.)	16 6	14 6
Naraguta, Nigeria	7 6	5 0
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	4 3	4 0
Penawat ($1), Malay	1 0	1 0
Pengkalen (5s.), Malay	10 6	10 0
Petaling (2s. 4d.), Malay	8 3	8 3
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	15 0	10 0
Siamese Tin (5s.), Siam	6 3	5 9
South Crofty (5s.), Cornwall	1 9	1 9
Southern Malayan (5s.)	10 0	9 6
Southern Perak, Malay	1 7 6	1 5 0
Southern Tronoh (5s.), Malay	5 9	5 6
Sungei Besi (5s.), Malay	6 6	6 3
Sungei Kinta, Malay	10 0	10 0
Tanjong (5s.), Malay	6 9	6 9
Tavoy (4s.), Burma	3 9	4 3
Tekka, Malay	13 0	13 9
Tekka Taiping, Malay	12 6	12 0
Temengor, Malay	1 6	1 6
Toyo (10s.), Japan	1 9	1 9
Tronoh (5s.), Malay	12 0	9 6
DIAMONDS:		
Consol. African Selection Trust (5s.)	13 9	10 0
Consolidated of S.W.A. (10s.)	4 6	4 0
De Beers Deferred (£2 10s.)	3 18 9	3 11 6
Jagersfontein	1 1 0	17 6
Premier Preferred (5s.)	2 0 0	1 15 0
FINANCE, ETC.:		
Anglo-American Corporation (10s.)	13 9	1 2 0
Anglo-French Exploration	8 9	8 0
Anglo-Continental (10s.)	3 9	2 6
Anglo-Oriental (Ord., 5s.)	6 6	5 6
ditto, Pref.	8 6	7 0
British South Africa (15s.)	1 3 0	19 6
Central Mining (£8)	6 15 0	7 5 0
Consolidated Gold Fields	1 3 0	1 2 0
Consolidated Mines Selection (10s.)	8 0	6 0
Fanti Consols (8s.)	5 9	6 9
General Mining and Finance	16 3	14 6
Gold Fields Rhodesian (10s.)	4 0	3 9
Johannesburg Consolidated	1 3 6	1 2 0
London Tin Corporation (10s.)	9 9	11 0
Minerals Separation	3 3 9	2 10 6
National Mining (8s.)	3	3
Rand Mines (5s.)	2 18 9	2 16 3
Rand Selection (5s.)	10 0	9 3
Rhodesian Anglo-American (10s.)	10 0	8 9
Rhokana Corp.	4 15 0	4 10 0
Rhodesian Selection Trust (5s.)	13 9	9 6
South Rhodesia Base Metals	2 0	2 0
Tigon (5s.)	9 6	7 0
Union Corporation (12s. 6d.)	2 16 3	2 12 0
Venture Trust (10s.)	4 6	3 6

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

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

BALL-MILL WORK INPUT

Report of Investigations No. 3056 of the United States Bureau of Mines, by J. Gross and S. R. Zimmerley, contains particulars of a device for measuring the work input to a laboratory ball-mill. The determination was found to be necessary in the course of a study of ball-mill grinding being carried out at the Intermountain Experiment Station of the Bureau at Salt Lake City, Utah. The device adopted was essentially that used by Haultain in measuring work input to rolls, it only being necessary to change the mechanism.

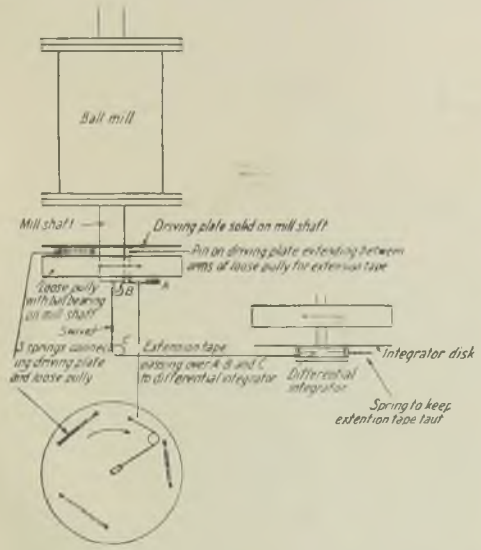


FIG. 1.—DIAGRAM OF POWER-RECORDING GEAR.

A diagrammatic sketch of the apparatus is given in Fig. 1. The pulley which rotates the mill is loose on the mill shaft and is equipped with ball bearings. This pulley is connected by means of three tangential springs to the driving plate, which is solid on the mill shaft. Power applied to the loose pulley is transmitted to the driving plate, and hence to the mill, by the three springs; the greater the resistance of the mill, the greater the spring extension. The extension of the springs is transmitted by the steel extension tape to the differential integrating meter.

The integrating meter is operated by two friction wheels in contact with the integrator disc, which revolves at a definite ratio of speed to that of the mill. The fiction wheels are held in contact with the disc by the spring suspension of the integrator and are connected to a differential gear cage, the revolutions of which are recorded on a counter such as is used in gas meters. Due to the differential gears the cage is stationary when the two friction wheels revolve at the same speed in opposite directions; this condition exists when the integrator is centred on the disc and corresponds to no load or to a zero spring extension. As the load is applied, the springs extend and move the integrator from the centre or zero point, resulting in a difference of speed between the two friction wheels. Due to the revolution of the differential cage this change in speed is transmitted to the counter. The integrator and extension tape system is kept taut by means of a light spring attached to the integrator, the spring having just enough tension to assure that the integrator returns to zero when the load becomes zero.

The integrator does not give direct readings of the work input, as the readings increase with speed or revolutions per minute and the spring extension is not in direct proportion to the load or pull. The integrator reading is, however, a true product of speed and pull. A given pull always results in the same spring extension and a given pull per revolution always gives the same reading, irrespective of speed. The relation between horse-power-hours per revolution and integrator-reading per revolution can thus be expressed by a calibration curve from which the work input can be obtained when time of running and number of revolutions are known.

The spring extension and the displacement of the integrator from the zero point are increased as the work input increases, so that the revolutions of the differential gear are a measure of work input. To convert the meter readings to work input, the apparatus was calibrated at various speeds with a Prony brake and also by means of a static load. The static method was particularly useful as a check on the Prony brake measurements and for those loads where the Prony brake readings were not steady enough for the required accuracy.

CALIBRATION WITH THE PRONY BRAKE.—A Prony brake was made to fit the mill shell, and readings were obtained with different loads and at different speeds. By plotting the horse-power-hours per revolution against the integrator-reading per revolution, the data for all speeds can be used to establish a single curve. This has been done in Fig. 2.

CALIBRATION WITH STATIC LOADS.—The mill was run at a definite speed and the belt then removed. A known weight was suspended from the driving pulley at a distance of $10\frac{1}{8}$ in. from its centre. The disc was then run at the speed which corresponded to the particular mill speed and integrator readings were obtained. The results of the static measurements plotted similarly to those obtained with the Prony brake are given in Figure 2. It will be seen that the Prony brake

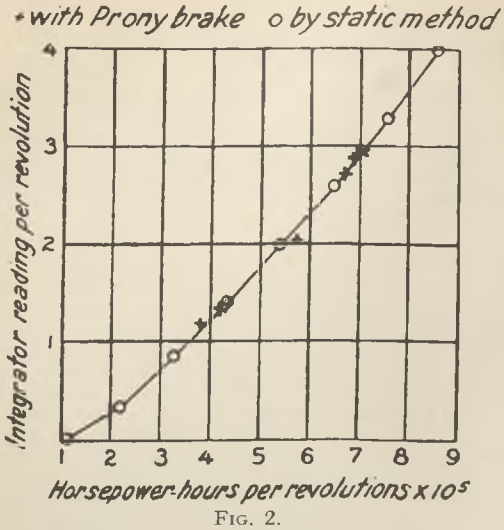


FIG. 2.

and the static method give essentially the same results. This curve is used for the determination of work input when springs of the same strength are used.

USE OF THE CALIBRATION CURVE.—To determine the work input to the mill, it is only necessary to know the mill revolutions and the integrator readings for definite periods of time. The figure obtained from the curve multiplied by the revolutions per minute gives the horsepower-hours per minute input delivered at the mill irrespective of motor efficiency, transmission losses, or belt slip. The only place in which belt slip affects the results is in the transmission to the mill or to the integrating disc, thus altering the speed ratio between these two from that obtaining during calibration.

Speed counters are used both on the mill and on the integrator disc so that any variation in the speed ratio can be noted and a correction applied, the integrator readings being directly proportional to the disc speed.

The curve may be considered as accurate for readings from 0·000015 to 0·000085 horsepower-hours per revolution. For readings below this the accuracy of results obtained with the springs used in the calibration may be questioned. For work input measurements below 0·000015 horsepower-hours per revolution, weaker springs are used, which was done in obtaining no-load-figures. However, in either case the curves obtained do not go through zero as they theoretically should unless the curve be bent sharply. The explanation of this lies in the fact that a certain pull is necessary before the springs begin to extend. Furthermore, a certain force is necessary to overcome the pull of the tension spring which keeps the extension tape taut. This does not affect the range in which the ball-mill experiments are made.

STAMP-MILL SCREENS

In *Bulletin* No. 29 of the Kolar Gold Field Mining and Metallurgical Society, F. W. Kendall gives some notes on improved methods of fixing screens in stamp-mills and full extracts from his paper are given here. The author says that stamp-milling is such an old-established process for the crushing of ores that it may seem presumptuous for him to suggest that in certain directions considerable improvements can be effected; improvements that would not only benefit the process, but also be welcomed by millmen and mill attendants. He says that his attention was first seriously drawn to the method of affixing screens to their frames through observing, soon after the introduction of 64 screening in the Mysore mine mill, the considerable screen chokage that was being experienced; much greater than one would have expected on changing over from the previous mesh in use, i.e. 256 mesh.

The author's experience with stamp-mill screens of woven wire has been extensive, varying with screens of 1,400 holes per sq. in. to the one at present in use in the Mysore mill, i.e. 64 holes per sq. in. of 18 s.w.g. wire, with an aperture of ·077 in. Although the paper deals particularly with 64 screening, it may be that screening of near sizes would exhibit similar tendencies; in any case certain details embodied in the paper apply to all types of woven wire screens.

To a large extent screen efficiency and stamp duty are interdependent, inasmuch as the gradual chokage of screens renders them gradually less efficient, resulting in an appreciable decrease in stamp duty, and a corresponding decrease in mill tonnage output. Screen efficiency may be interpreted as the passing through the screen of as great a quantity of pulp as possible during the time the screen is discharging and also obtaining the utmost effective life before discarding it. The discarding of screens on account of being heavily choked, although at the time not worn out, is not unknown in stamp-milling. This would not happen if an easy and effective way of clearing a screen, other than the usual scraping or brushing, were found. Although scraping or brushing a screen for clearance is universally practised, it is nevertheless an unsatisfactory method, more especially with the finer mesh screens, on account of the damage caused to them in addition to insufficient clearing. The fact that the size of the screen aperture increases, due to the wear of the wires, does not affect the issue when stamp-milling is followed by fine grinding.

As is natural, fine screens become choked in a very short time, but when screens with larger apertures are used this tendency to chokage decreases, until a critical point is probably reached, when possibly the stamp duty does not come up to expectations, due to excessive chokage that was not anticipated; from this point the tendency to chokage continues to decrease. It may be that screens with apertures in the vicinity of 64 holes per sq. in. become more quickly choked on account of the rapid reduction of the ore by the stamps to a size approaching the screen aperture and at times augmented by a greater quantity of a similar product contained in the fines from the mine, as well as in the fines produced by the rock breakers during preliminary crushing.

Excessive chokage may also be more in evidence at the time the depth of discharge is least, when

still more ore of a near size to the screen aperture is produced. In any case, the large grains of ore causing chokage in a 64 screen were found to be many-pointed, and for this reason, it may be assumed, would become wedged more readily in the meshes. On the other hand the ore particles choking finer screens were found to have their edges rounded, due of course to their retention in the mortar box for a much longer period, and thus subjected to far more abrasion.

In choked 64 screens viewed through the microscope, the meshes were found to be choked with more than two particles of ore. This was probably accounted for by the fact that the large particles, being many-pointed, quickly become wedged in the meshes and so rapidly reduce the screen aperture, and through the addition of from two to six small pieces, the meshes become completely choked. The number of small pieces assisting in the chokage varied according to the time the screen worked, the numbers being ascertained by actual counting, and then averaged.

Several tests were made to ascertain the average number of small pieces to large pieces choking a 64 mesh at stated times, working under normal conditions, with the following results :—

Time : Hours.	*No. of Small Pieces to 1 Large Piece.*
0·5	1·83
1·0	2·05
2·0	2·14
3·0	2·42
4·0	2·76
8·0	3·38

It will be seen from these figures how very quickly the screen becomes reduced to a comparatively fine mesh screen, therefore the need for an efficient method of screen clearance is very necessary.

An experiment was made to try and minimize the amount of chokage of the screen by small ore particles. It was thought that if the water-feed to the mortar box was considerably increased, possibly the extra splash, together with the reduced density of the pulp, might minimize chokage on account of the smaller particles being washed out of the meshes. The result of this experiment was unsatisfactory, for there was actually a greater number of small pieces. With the normal water-feed the average number of small pieces to one large piece was 3·2, while with excessive water-feed the average number was 3·7 small pieces.

The determination of the degree of chokage was a debatable matter, and presented certain difficulties. The first method employed was to clear a choked screen, using a blunt-pointed style. From the product, all sand passing through a 900 (30 by 30) sieve was eliminated, for this was not considered as aiding the chokage (up to this time the microscope had not been used). The plus 900 product = A, was weighed. Next the − 64 + 256 product (B) contained in one sq. in. was weighed. In other words 64 large pieces were weighed, these being considered as constituting true chokage. Then $\frac{A}{B}$ = number of sq. in. choked. In view of what the microscope subsequently revealed with regard to small pieces, this method was useless.

Next a new screen was weighed before, and again after, working for 48 hours, when it was found to have gained in weight by 13·30%. This test, however, was not accepted as giving a reliable result.

Finally, it was considered that the only dependable method was to count the total number of meshes choked. This task was undertaken, safeguards being provided to ensure accuracy.

At this stage the author digresses somewhat before giving the results of the counting, in order to bring forward a method for the clearance of choked screens which produces better results than either scraping or brushing, these being the methods commonly practised. This enables a comparative tabulation to be presented embodying the results of experiments made to ascertain the number of holes choked (1) before any attempt at clearance, (2) after the use of a scraper and (3) after adopting the new method.

The fact that 64 screening becomes inefficient in a comparatively short time on account of being choked, thus necessitating the frequent use of a scraper with unsatisfactory results, the idea was conceived that if a choked screen were turned inside out at frequent intervals (at least once in every eight hours), clearance would be automatically effected during the process of crushing.

In order to enable a screen to be turned inside out quickly, the question of fixing screens to their frames had to be considered ; for the turning inside out of screens, even if not more frequently than once per shift, would entail a lot of extra work for millmen, or mill attendants. A simple method, at least for fairly coarse screens, is as follows :—

The wooden screen frames previously used are recessed to the depth required to accommodate the selvedges of the screen, amounting to approximately $\frac{3}{16}$ in. with the 64 screen. To attach the screens to their frames after having been placed in position, two flat plates 2 in. wide, $\frac{1}{8}$ in. thick, and the length of the frame are used for each frame. These flat plates are placed on the frame, the plates just covering a selvedged side of the screen. The plates are held in position by $\frac{3}{8}$ in. bolts, which pass through the frame, the bolts being fitted with wing nuts to avoid the use of a spanner. To facilitate the removal

TABLE I.

Time Worked Hours.	*No. of Holes Choked.*	*Percentage of whole Screen Choked.*	*No. of Holes Remaining Choked.*		*Percentage of Efficiency.*		*Increased Efficiency of Turning over Scraping Percentage.*	*Percentage of Whole Screen Remaining Choked.*	
			After being scraped.	After being turned.	Through being scraped.	Through being turned.		After being scraped.	After being turned.
0·5	2889	8·207	1191	536	58·77	81·44	22·67	3·383	1·522
1·0	3781	10·742	1579	960	58·23	74·61	16·38	4·485	2·727
2·0	6043	17·168	1716	1113	71·60	81·59	9·99	4·875	3·161
3·0	8153	23·162	2144	1457	73·70	82·12	8·42	6·091	4·139
4·0	8746	24·847	2913	1753	66·69	79·95	13·26	8·275	4·980
*8·0	9753	27·707	4520	2457	53·69	74·81	21·16	12·841	6·980
*225 & 224	—	—	5629	2380	—	—	—	15·991	6·761

* During these tests, the screens to be scraped were scraped at the end of each four hours, and those to be turned were turned at the end of each eight hours.

of the plates in order to release the screen, the plates are slotted instead of having bolt holes, consequently by merely slackening the wing nuts, the plates are easily removed and the screen freed.

By this means a simpler and more rapid method is provided to enable the extra work of turning a screen inside out to be done. Incidently, since this method has been in vogue, screen life has been slightly prolonged, i.e. from an average of 522 hours to an average of 535 hours.

The details given in Table I show the degree of chokage by ore particles of 64 screening which occurred at stated intervals. It should be noted that at the expiration of the time given for clearance, either by scraping the screen, or by turning it inside out, each screen worked, prior to removal, a further period of ten minutes, to enable a fair comparison to be made. Battery conditions during the experiments were as similar as practicable.

From the forgoing figures it will be noted that screens are cleared much more effectively by being turned inside out than by scraping. The scraper used consisted of a solid U-shaped piece of wood, with a long handle for manipulation, covered with screening ; a common type of scraper.

With what frequency screens should be scraped is a matter of opinion, and much depends on the size of the meshes in use and also the time at the disposal of the millmen. Although regular times may be laid down for the job, it may often not be possible to comply with the rule, so that, if at least equal clearance can be effected by some other means in half the amount of time, then scrapers with their attendant costs, can be abolished, and something will have been accomplished. With very coarse screens chokage does not give the same amount of trouble as far as ore chokage is concerned ; but, at the same time, tramp wood and debris can at times be the cause of a deal of screen inefficiency, which scraping will not clear without the removal of the screen.

Results of experiments which are based on tonnages crushed are probably in many cases arbitrary, unless these tonnages are very considerable, extending over a long period (of months' duration), and for that reason few experiments based on tonnages are quoted. The following, however, are the results of experiments carried out with the object of ascertaining it by turning a screen inside out as a means of clearance ; double the time may be allowed to elapse before screen clearance is attempted, compared with the time taken by the usual method of scraping, without loss of efficiency.

Test No.	*Method of Clearance.*	*Time Effected.*	*Total Hours Worked.*	*Tons Crushed.*	*Stamp Duty.*
1	Scraping . .	Every 4 hours	225·80	295·00	8·40
2	Turning inside out	,, 8 ,,	224·50	398·00	8·51
3	Scraping . .	,, 4 ,,	536·03	936·37	8·38
4	Turning inside out	,, 8 ,,	531·73	938·78	8·47

The results of these experiments prove that when the clearance of a screen, choked with ore particles, is effected by means of turning the screen inside out, it may be allowed to work for double the length of time compared with scraping, before again attempting the clearance, and also that there is no loss of crushing efficiency ; in fact stamp duty would probably be slightly higher. Although these results were obtained with 64 screening, there is no reason to suppose that similar results would not be obtained with any type of screen that was at any time liable to become clogged.

It is evident that the more frequently screens were turned inside out, the greater their efficiency would become, and the greater the contrast between the two methods. The matter of turning screens inside out frequently, for the sake of screen efficiency, raises the important point of the amount of extra work that would be entailed. Mortar boxes would have to be opened much more frequently in order to remove the screen frame thus resulting in a millman's work being much increased.

The removal of a screen frame is generally no light work, to say nothing of the time ordinarily involved in the operation being lost. Probably one of the most exasperating things a millman has to contend with is a shoe, or head, that with the most careful attention on his part, seems to be determined not to stay on, this being due to causes not immediately apparent. When this occurs, he has to continually open and close the mortar box which, as already stated, is no light work. Then again, it may be necessary to remove a screen that has suddenly broken at a time when the millman is fully occupied with other work, or, as sometimes happens, he is about to leave the mill on the expiration of his shift, possibly a long one, when, as bad luck would have it, either of the aforementioned breakdowns occurs. He knows that it will possibly take him at least 15 minutes to do the job, even if it is only the renewal of a screen ; nevertheless as it has happened on his shift he will stay on and tackle the work, regardless of being thoroughly tired, in order to hand over the mill in good order. With these annoyances all in the day's work he would not feel very delighted to have the extra work thrust on him of frequently taking out screen frames and replacing frames with screens previously turned.

This leads to the question as to whether the method usually adopted for the closing of a mortar box is satisfactory. It is admitted that the method of closing with a wooden screen frame with its complemental "covering" or "head" board is, though laborious, perfectly simple. Nevertheless it is a very laborious method, and at times can be very fatiguing. The upkeep is also a matter for consideration.

In attacking the problem of closing a mortar box in any new way, there are certain conditions which have to be fulfilled, such as :—

(*a*) Simplicity being maintained.

(*b*) The method less laborious, and at the same time the work expedited.

(*c*) The screen must become more efficient, and if possible its life prolonged.

(*d*) Finally, the upkeep costs considerably reduced.

If these conditions are fulfilled, then very great improvements will have been effected in stamp-milling, and worth bringing to the notice of this society. Moreover the gratitude of millmen will have been earned, especially of those working in unfavourable climates, if conditions (*a*) and (*b*) are realised.

Stamp mills which are not in the fortunate position of having spare batteries would derive considerable benefit if the operation of opening and closing of a mortar box were made easier.

and at the same time more expeditious. Even if spare batteries are available, from every point of view it is not desirable to bring them into operation unless for a stoppage of considerable duration.

Attention is directed to a device which is operating with highly successful results in the Mysore mine mill by fulfilling the conditions stipulated above. Through its adoption wooden screen frames with their complements have been scrapped, as the device permits the screen itself to be handled at the mortar box. Screens of all meshes, varying from very coarse to very fine, can be removed or replaced in the exceptionally quick time of under a minute, and with very considerably less effort on the part of the millman or operator. Screens of any width can be accommodated by the suitable adjustment of the device, the means for which are provided. As previously stated, very coarse screens become, in time, badly choked, not so much with ore particles, as with tramp wood and debris; if, however, they were accommodated in the new device, they would become more efficient, for they would be cleaned more frequently on account of their easy removal. If very fine screens are used, it will be necessary to "frame" them in a light, hoop-iron frame, fixing them with ¼ in. bolts, using thumb screws or wing nuts for tightening them. This frame would be affixed to the device in the same way as the coarser screens, and, being easily removable, would also be frequently turned inside out to effect clearance of chokage.

The following is a description of the device (Fig. 1): A frame of steel plate fits around the outside of the frontal opening of the mortar box. By providing a tapped ¾ in. hole on the outside of each of the two key ways and supplying these holes with studs (using tail lock nuts for security), sledge hammer work, so far as the removal of screen frames is concerned, is entirely dispensed with. The same keys, or drifts, used for the retention of wooden screen frames in position, can be used as filling pieces between the key way and the frame. It is preferable, however, to dispense with the cumbersome iron keys, or drifts, and use for filling pieces hard wood lined on two sides with strap iron, the sides lined being the one against the frame and the side facing outwards which has to receive the pressure of the stud point; the latter is supplemented with a further short length to act as a renewable liner which can be easily and cheaply replaced when necessary.

To the steel frame is attached an adjustable sliding extension plate which enables the space between the screen and the top of the mortar box to be closed. The extension plate is attached to the frame by means of studs (also provided with wing nuts) and is quite free from the above mentioned iron keys or drifts. The keys or filling pieces need releasing only (1) when the depth of discharge requires altering, or (2) when the frame has to be entirely removed.

If, for the purpose of regulating the depth of discharge, lengths of wood (termed outlet boards

DEVICE FOR FRONTAL CLOSING OF STAMP MILL MORTAR BOX
(COMBINING SCREEN FRAME)
— SCALE 3"-1' —

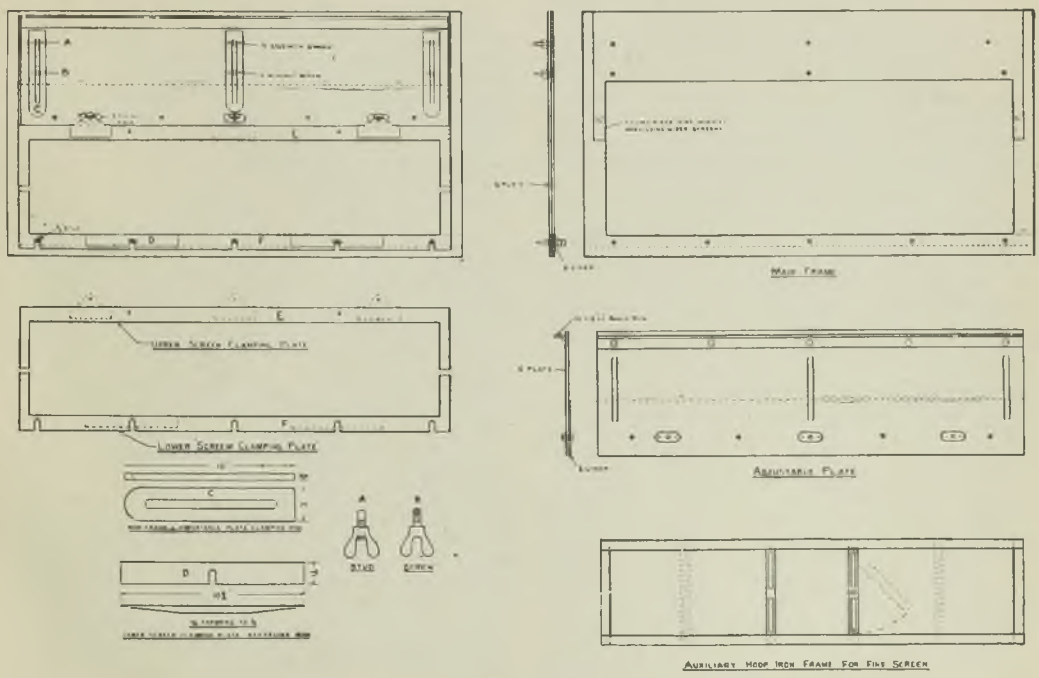


FIG. 1.

by some people) of varying thickness are interposed between the screen frame and the mortar box, the removal of the device from the mortar box is not necessary; for, by having the existing boards sectionized they can be easily exchanged, as required, by merely raising the device. In order to allow the device to be raised the keys or filling pieces have to be loosened and this is easily done by slackening the studs. This operation is nothing like as hard a task as when wooden screen frames with their complements are used, the combined weight of which is considerable (as much as 105 lbs. or more); for the latter practice necessitates the keys being driven in with considerable force to enable the covering board, not merely to be pressed firmly against the mortar box, but also to be firmly resting on the screen frame, so as to obtain a close fitting joint between frame and covering board. It must also be noted that this joint does not always remain a close fitting one, for abnormal vibration sometimes causes the joints to open, resulting in the undesirable leakage of pulp which has to be rectified by the laborious method of withdrawing the keys and then refixing the offending board.

The retention of the screen in position with the new device is by means of two clamping plates, an upper and a lower one. The upper clamping plate is hung on two studs which project from the adjustable plate, and is held firmly in position by two clamps also fixed on the adjustable plate, and which operate on $\frac{1}{2}$ in. diameter studs with wing nuts. On slackening these wing nuts the clamps can be turned aside, and the main clamping plate removed, thus freeing the upper side of the screen. The lower part of the frame is fitted with five $\frac{3}{8}$ in. studs, each projecting outwards. These studs also act as pegs on which both the screen and its slotted clamping plate can rest thus simplifying the replacement of a screen into its correct position. The position of these studs, for use with 64 screening (which has a $\frac{1}{2}$ in. selvedge), is $\frac{9}{16}$ in. below the line of pulp discharge.

When using screens with little or no selvedge, the position of the studs is determined by allowing enough space on the frame for the screen to rest against, and at the same time be gripped by the clamping plate; from $\frac{3}{8}$ in. to $\frac{1}{2}$ in. will suffice for the purpose, although, under normal conditions, two studs, fitted with wing nuts, are sufficient for use with the lower clamping plate in order to retain the screen firmly in position. If the clamping plate should get accidentally bent, an additional stud or studs (as the frame is fitted with five studs) can be used to overcome any unevenness in the grip of the screen. Under normal conditions the slackening of the two lower wing nuts allows the clamping plate to become loose, and then the screen is completely freed from pressure and can be entirely removed.

As previously stated, the operation of opening a mortar box takes less than a minute, and consequently screens, shoes or heads can be attended to with the minimum loss of time, and expenditure of labour, the combined weight handled during the operation of removing a screen being only 22 lb. compared with the previously mentioned weight of 105 lb. or more.

When dies or liners require attention, the adjustable extension plate can either be raised or removed, which is easily done according to the operator's inclination; and by this means the mortar box frontal opening is extended to facilitate the millman's work. The frontal opening is similarly extended when wider screens are required to be used.

The important question of upkeep cost has received due consideration; for where excessive wear is likely to occur, the device is protected with liners, which can be easily replaced, utilizing scrap iron, when available, for the purpose. The wear of liners that have been in use for several months is inappreciable.

When describing the new device it was mentioned that any width screen could be accommodated; from this statement the question arises as to whether any advantage would accrue through the use of wider screens than those normally used, i.e. 12 in. wide. An experiment carried out on this subject showed that no appreciable increase of output would be obtained, if an increased depth of screen were substituted for the depth normally used. The experiment was made with 64 screening, and similar results would probably be obtained with screens of other meshes.

To obtain a definite opinion as to whether there is, or could be, any increase in output, two methods were adopted, viz. one by tonnage, and one which might be described as ocular. Experiments were carried out with two screens having a depth of 15 in. and 18 in. respectively. The mode of making a screen of the depth required was to weld electrically two pieces of screening together, encasing the welded joint between two lengths of strap iron $\frac{3}{4}$ in. in width, thereby ensuring that any oversized holes produced by welding were closed. The average number of tons that passed through these screens was 931 tons, and the average duty 7·996 tons per stamp. No increase of duty was thus obtained.

A curious feature was noticed in regard to these screens after being in use, and that was that the upper or additional portion of each screen had become excessively clogged with ore particles.

The first impression was that as the angle of direct splash is such that no splash having any degree of force could possibly reach so high, the meshes had become clogged by particles of ore from indirect splash trickling down the screen and these aided by the vibration of the mill became wedged in the meshes. Now if this were so then one would expect to remove them fairly easily by prodding with a style. The reverse, however, was the case, for their removal was extremely difficult, signifying apparently that there was force in the splash.

To obtain ocular demonstration of the result of the splash that would reach higher than the depth of an ordinary screen, an experiment was made by filling a frame with stoggy clay to a depth of 1 in. This frame was fixed immediately above an ordinary screen frame. The idea of the experiment was that, if the pulp splashed with any degree of force against the clay, it would, to a certain extent, be revealed at the end of a quarter of an hour. One of two things would be sure to happen: either the clay would be practically washed away, or if not, the particles of ore impelled against it would be well embedded. The clay, however, was found to be practically intact, with the ore particles merely adhering to it without being embedded. It may thus be safely assumed that little, if any, benefit would accrue by increasing the screen area.

The details of the new method of closing mortar boxes are shown in the drawing (Fig. 1) and in the photographs (Figs. 2 and 3). From the description given, it will be recognized that a feature greatly in its favour is that, in securing the device to the mortar box, little or no alteration of the mortar box is necessary and that it is possible to use the keys, or drifts, that may be in stock. It is, however, preferable to provide the mortar box with studs, and use lighter filling pieces of the type previously described. The discarded iron keys, or drifts, would in all probability be of use for other purposes, such as tappet keys, etc.

In the Mysore mill the 64 screens invariably break at either end. With regard to screens breaking in this position it makes no difference whether the screen is tacked on a wooden frame, thus making the screen rigid, or clamped to it, and so allowing the screen to have slight play.

The following experiments were made to ascertain if, by modifying the wooden screen frame, any improvement would be noticed.

FIG. 2.

FIG. 3.

(*a*) A strip of rubber insertion $\frac{3}{4}$ in. wide and $\frac{1}{8}$ in. thick was interposed between the screen and the frame to act as a cushion. By this means a slight increase in the life of the screen was obtained, amounting to 1·96%. The screen, however, broke in the usual place.

(*b*) A bar of $\frac{1}{2}$ in. round iron was affixed to a screen frame on the outside of the screen in such a manner as to allow the screen to rest against it. The bar was fixed $10\frac{1}{2}$ in. from one end of the frame. The frame was reversed daily to permit the end with the bar to be on the right and left of the box alternately, in case working conditions differed in the box. This modification did not improve matters; in fact, the reverse happened, for the screen life was less, the wires breaking at the bar first.

(*c*) A screen frame with four bars equally spaced, was next tried with no better results.

(*d*) A new screen was cut into two sections, $39\frac{1}{2}$ in. and $9\frac{1}{2}$ in. long respectively, and these sections were affixed to special wooden frames. It was thought that the smaller, and consequently more rigid, screen might last the longer time. The shorter screen, however, broke first, only working for 448 hours, 36 minutes, whereas the longer screen lasted for 538 hours, 42 minutes. The longer screen, however, eventually broke at one end.

As these experiments produced negative results, the inference is that the ends of a screen get a considerably greater quantity of coarse pulp striking diagonally against the wires, this being due to stamp swash, from not only the end stamp, but also from its neighbour, with the result that the wires are gradually being cut away through a shearing action.

The next problem to be solved was how to reduce screen wastage, not that screens are expensive, but a principle is involved. Screens in some mills break more frequently at the ends than anywhere else, with the result, that from 90% to 96% of serviceable screening gets discarded. Speaking generally, wherever the breakage in a screen occurs, a lot of good screening is thrown away.

When attempting to effect economy in screening the following points must be considered:—

(*a*) Will the method of affixing the screen sections (those that would be forthcoming from the portion of serviceable screening left after discarding the part actually damaged) to the frame, and each to the other, involve such a reduction of stamp duty as to preclude sectionizing, and so allow the practice of discarding large quantities of good screening to continue.

(*b*) Or, is it preferable to continue an old established method of what for a better name is termed patching, which consists in covering the damaged portion of a screen with a drill, canvas, or insertion-lined piece of wood, ranging from 2 in. to 4 in. width, firmly wedged between the upper and lower sides of the wooden screen frame. This in effect is sectionization, and although practised the world over, is, it is suggested, the incorrect way to sectionize. Admittedly, it is done in most cases because, at the moment the breakage occurs, there is no time for changing the screen, and it often happens that the patch remains in position much longer than was intended. The result is a much greater loss of screen efficiency than if considered sectionization were the rule.

The method suggested for sectionizing, and which has proved to be quite satisfactory, is as follows: The damaged screen is first cut into the required sections, these are then butt-jointed and held together by two clamping irons. The clamping irons are made of the narrowest possible flat iron $\frac{1}{8}$ in. thick, the usual width being from $\frac{3}{4}$ in. to 1 in. wide. The length is determined by the width of the screen between selvedges. The irons, with the ends of the screen between them, are held firmly together by $\frac{3}{8}$ in. bolts having wing nuts, or thumb screws, to avoid using a spanner.

The procedure suggested when a screen is broken

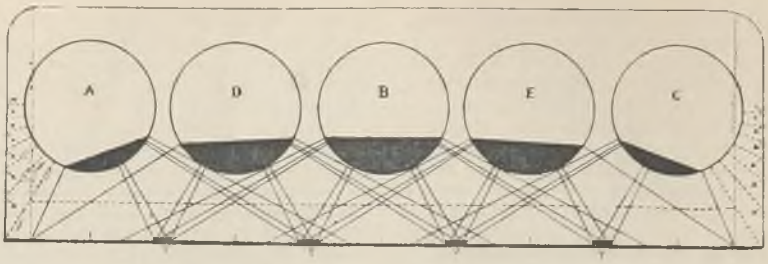


FIG. 4.—SHADED PORTIONS REPRESENT TOTAL STAMP AREA PRODUCING DIRECT FRONTAL SPLASH: A, B, C, D AND E ARE STAMPS IN ORDER OF DROP; Y—THESE ARE SUGGESTED PORTIONS FOR SCREEN SECTIONIZING IRONS.

is to remove it at once and replace with a new screen (or one previously sectionized) for, with the new type frames, this can be done nearly as quickly as patching and with more satisfactory results. Later the damaged screen can be appropriately sectionized.

In an attempt to solve the problem of where the section irons should be placed to reduce as much as possible the loss of duty that the introduction of these irons might entail, use is made of a hypothetical diagram, which, by means of radials drawn from the centre of each of the five stamps to the screen, shows the direct frontal discharge of each stamp. To make this diagram, the average outward limit of frontal splash had to be ascertained. This was done by projecting lines at right angles from the centre of Nos. 2 and 4 stamps towards the screen, and marking them in chalk on the lip of the mortar box (Fig. 4).

With the screen in position these two stamps worked in turn and the remaining four stamps were kept idle. While these stamps were at work, chalk marks were made on the screen indicating where the limit of splash was considered to extend. Three persons, independently, did this marking, and it was found that the distance from the centre chalk mark to the chalk mark indicating the extent of splash averaged 18 in. or a length of 15¾ in. from the circumference of the die, and the angle made by this line and the line of the screen frame, being as acute as from 25 to 27°.

It is obvious, therefore, that the pulp issuing through the screen at a point at right angles to the centre of the stamp and extending to the extreme limit of frontal discharge, gradually decreases in size, until it issues as very fine sand, if not slime. From the foregoing it follows that when sectionizing is practised, the position for the clamping irons (holding sections of screens together) should be a matter for consideration. From a number of actual crushing tests made with 64 screening, the tonnage lost through sectionizing is very little, but with finer screens in use this would be a more serious matter; at the same time if there is to be a slight loss, then it should be minimized, by attention to the position in which the sectionizing irons are to be placed.

On reference to the diagram it may possibly appear at first sight as if either between the first and second, or between the third and fourth stamps, would be the initial position for the sectioning irons to be placed. And this opinion might be emphasized when a third section had to be placed in position, for the reasoning would be that three stamps (Nos. 2, 3 and 4) would be the least affected, and that when only one set of irons was in use, little effect would be felt by at least four stamps. It is suggested, however, that this may not be correct, and the discharge may be least affected if the clamping irons were situated between Nos. 2 and 3 or between Nos. 4 and 5 stamps. The reason for this choice is, that although more direct frontal splash from an individual stamp may be affected, nevertheless there is the probability that the splash resulting from the swash around the back of the mortar box, which probably accounts for a large proportion of screen discharge, would be least affected.

It may be well to mention that sectionizing irons are not necessary when screen breakages are small, due to initial faulty wires. If the defect is spotted early, a small bolt with a nut and washer will cover the breakage, and suffice to carry on for a considerable time. If the breakage is somewhat larger, minimum sized plates bolted one each side of the break, will answer the purpose until a greater breakage calls for sectionizing. The following are the results of some tests made with

TABLE II

Tons Crushed.	*Position of the Sectioning Irons.*	*Time Taken.* Hrs.	Mins.	*Stamp Duty for 24 Hours.*	*Difference in Time Compared with Exp.* (a) *(plus).* Hrs.	Mins.	*Difference in Duty Compared with Exp.* (a) *(minus).*
(*a*) 100	Full screen, no sections	59	59	8·002	—	—	—
(*b*) 100	*Three Sections*— Sectionized between stamps 2 and 3, and stamps 3 and 4	60	—	8·000	—	1	0·002
(*c*) 100	*Three Sections*— Sectionized between stamps 1 and 2, and stamps 4 and 5	61	16	7·834	1	16	0·168
(*d*) 100	*Five Sections*— Sectionized between stamps 1 and 2; 2 and 3; 3 and 4; and 4 and 5	61	24	7·817	1	24	0·185

the object of ascertaining (*a*) if sectionizing would be the cause of an appreciable reduction in stamp duty and (*b*) what extra life, and extra tonnage, could be obtained by sectionizing the portion of screening which ordinarily is thrown away.

(*a*) *Effect on Stamp Duty.*—Four consecutive experiments each with 100 tons of ore direct from the Bigelow crushers, were carried out in the same battery. The ore from the crushers was chosen in order to minimize, as far as possible, any variation that might occur in the quantity of fines fed to the battery, which would probably have been appreciable had a mixture of fine and coarse ore been used for the experiments. Furthermore, the conditions under which each experiment was conducted, were as similar as practicable.

As stamp duty is governed by several factors, the above decreases in stamp duty may not of necessity, have been entirely due to sectionization; in any case, the conclusion to be drawn is not adverse to the principle of sectionizing mill wire-woven screens, at any rate those of the coarser variety.

(*b*) *Effect on Screen Life.*—Experiments were made with five screens, to ascertain what extra life might be expected by sectionizing the portions of screens usually discarded. The following results were obtained:—

The average amount of a whole screen sectionized	96·00%
The average life of the screens before first break	539 59 hours
The average total life before finally discarding	686·25 ,,
The average extra life obtained through sectionizing	146·66 ,,
Percentage of increased life obtained	20·86%
The average extra tonnage crushed, per screen	257·56 tons.

From the foregoing evidence the author considers that the principle of sectionizing damaged screens is sound, for once the irons for the purpose are made the upkeep cost is negligible, more especially where old scrap is available.

RADIUM IN ONTARIO

The occurrence of radium ore near Wilberforce, Haliburton county, Ontario, is described by H. S. Spence and R. K. Carnochan in the publication of the Canadian Department of Mines entitled "Investigations of Mineral Resources and the Mining Industry, 1929," and a summary of the geological descriptions of the occurrence are given here.

The authors state that the deposit is situated on lots 4 and 5 in concession XXI of the township of Cardiff, Haliburton county, about 1½ miles east of the village of Wilberforce, on the Irondale, Bancroft and Ottawa branch of the Canadian National Railway. It lies one-half mile south of the Wilberforce-Bancroft road and of the railroad, on the north edge of the ridge bordering the valley through which the railroad runs. It can be reached by automobile from either the east or west, the distance by road from Toronto being about 150 miles and from Bancroft, 20 miles. The Ontario Radium Corporation owns a total of 456 acres, comprising the above-mentioned lots and also lots 4, 5, and 6 in concession XXII immediately to the north.

Topographically, the region is one of medium relief. The altitude at the railroad, north of the deposits, is 1,200 ft., from which point southward the ground rises gently in a series of benches to an elevation of 1,500 ft. at the main pit. The overburden at the point of discovery is generally light, consisting of seldom over 20 in. of sandy or gravelly soil, and rock outcrops are abundant. The part of the property comprising the main discovery site has been burnt over and supports only a light growth of small timber. A small lake occupies a depression on the second bench below the pits, being fed by springs issuing from the ridge. Several such springs have been located and are regarded by the company as assets of importance, since their water has been tested and found to be strongly radioactive, as is also the water of the lake.

The first discovery of radium ore in the Wilberforce district was made in 1922 by W. M. Richardson, a prospector and miner with Alaska and Yukon experience, who had come to Wilberforce in connexion with the finds of molybdenite that had been made near that place and had taken up residence about one-half mile north-west of the site of the present operations. In the course of prospecting the district, Mr. Richardson found a heavy, black mineral in surface outcrops of pegmatite at different points on the property, and having obtained a sample of Joachimstal pitchblende, identified this mineral as uraninite. He, therefore, took up the mining rights on lots 4 and 5 in concession XXI, and on lot 4 in concession XXII, and proceeded to open up a number of small prospect pits and trenches. A sample of the uraninite sent by Mr. Richardson to Ledoux and Company, of New York, for assay was reported by them to contain 58·35% uranium oxide (U_3O_8), equivalent to a radium content of 147 milligrams of radium per ton.

Late in 1922, Dr. W. G. Miller visited the property and described it briefly in the *Canadian Mining Journal* of January 11, 1924.

In 1923, Mr. Charles Baycroft was engaged by a Toronto syndicate to make an examination and report on the deposit. Mr. Baycroft opened a 30 ft. trench on one of the westerly outcrops, and from this sent a 200 lb. sample to Dr. T. L. Walker, in Toronto. Concentration tests were run on this sample, but the syndicate did not proceed with development, and except for further minor prospecting by Mr. Richardson, there was no other development until the present owners acquired the property in 1927.

In 1926, Dr. G. E. Richards, Director of the Department of Radiology, Toronto General Hospital, had visited the property and secured samples of the ore and spring waters. With respect to the latter, Dr. Richards reported that three samples of water taken at various points all showed distinct radioactivity.

In 1927, Mr. M. D. Kennedy made a report on the property to the present company, who in 1929 commenced their first development work. Up to this time, attention had mainly been focussed on several outcrops of pegmatite that represented the points of original discovery of uraninite. Two of these outcrops lie fairly close together on lot 5, concession XXI, while a third, upon which most work had been done, lies about 2,000 ft. to the west of the above, on lot 4. Prospecting of the ground between these two points early in 1929 led to the discovery of a well-defined break or vein, quite distinct from anything found hitherto. It is upon this lead that attention has since been centred and upon which work is

proceeding at the present time. All of the three shipments of ore made to the Mines Branch in 1929, and upon which tests were run, came from this vein.

In addition to shipping ore to the Mines Branch for test, the company has recently forwarded a large sample of picked uraninite to the Imperial Institute, in London. As a result, they have enlisted the interest and services of that body, and also of the British and General Radium Corporation, in the matter of further development and of marketing of products, or of the eventual extraction of radium from the ore. In the last connexion, the company are highly desirous that Canada should receive the fullest benefit from the possession of a domestic supply of this precious element. In the event, therefore, of the deposit proving commercial, they wish, if this be possible, to have the extraction done in Canada, and the recovered radium made available for Canadian hospitals, etc.

General Geology.—The only detailed geological report on the Wilberforce district is that of Adams and Barlow, published in 1908. No special mention is made in this report of the area immediately around the deposit under consideration, and at that time the only local occurrences of economic minerals known were a few small deposits of mica and phosphate.

The map which accompanies the report shows the site of the uraninite discoveries to consist of a narrow east-west band of sedimentary gneiss, much invaded by granite (pegmatite) dykes. A parallel belt of white crystalline limestone occupies the whole of the valley below the deposit to the north, the gneiss-limestone contact crossing the north half of lots 4 and 5. This contact probably is more or less parallel to the pegmatite with which the ore is associated and not far north of it. An area of several square miles immediately to the south and west of the gneiss band is left blank as to geology. Surrounding this area, lies a complex assemblage of bands and islands of crystalline limestone, amphibolite, gneiss, nepheline, syenite, and granite, the latter in part massive and in part gneissic. A large batholith of granite is shown south of the deposit, its northern rim being about five miles distant. This batholith connects by a narrow neck with a second mass of more gneissic granite lying to the north-east. From this, a tongue is shown extending westward to within about a mile of the property. The many areas of pegmatite shown invading the rocks adjacent to these granite masses are possibly genetically related to them, though this is only theory. The pegmatite with which the uraninite is associated contains little or no free quartz, and the same holds good for a number of other pegmatites examined by the writer in Cardiff and adjacent townships. In some instances these pegmatites cut, or are in close proximity to, areas of nepheline syenite, and for this reason, as well as on account of certain conspicuous peculiarities in mineral composition, the writer is inclined to view them as pegmatitic phases of syenite rather than of granite.

Geology of Deposit.—With respect to the geology of the uraninite deposit itself, the following notes are based on an examination made in September, 1929, supplemented by information supplied in part by the owners and in part taken from Mr. Baycroft's report made in 1924.

West Pit.—Mr. Baycroft's report deals with that part of the property where the first discovery of uraninite was made in 1922 and upon which most of the development work was done prior to 1929. At this point is situated the most westerly opening on the deposit, a narrow open-cut about 6 to 8 ft. deep and 50 ft. long, entirely in pegmatite. The cut is at right-angles to the strike of the pegmatite, which has an approximately east and west direction. The opening does not disclose either of the walls of the dyke, which, according to Mr. Baycroft's report, is about 350 ft. wide. The character of the pegmatite is generally uniform for the whole length of the cut. The rock consists essentially of a coarse-grained, buff-coloured felspar, probably orthoclase, though no samples were taken for analysis. There are numerous irregular, miarolitic cavities, some of them of considerable size, their walls being lined with well-developed felspar crystals. Free quartz is conspicuously absent from the rock. Here and there through the dyke mass occur masses and large crystals of magnetite, the most abundant metallic mineral. Small amounts of molybdenite and chalcopyrite also occur, as well as biotite mica and zircon. Only at one place in the east wall of the cut, is any uraninite now visible. At this point, there is a small mass of uraninite enclosed in felspar, the latter carrying yellow and orange incrustations of uranium salts. According to the owners, however, considerable disseminated uraninite was encountered when the cut was made. This would appear to be borne out by the tests made by Dr. Walker on the 200 lb. sample from the opening sent to him by Mr. Baycroft. This sample is stated to be representative of 30 ft. of the cut and to have yielded over 1% of U_3O_8.

East Pits.—Several small pits have also been opened on outcrops of what is presumably the same pegmatite at a point about 2,000 ft. east of the above opening. The rock here is essentially similar to that in the west cut, being a medium-to coarse-grained syenite pegmatite; in one of the pits it contains considerable fluorite. Of interest is the occurrence in one of the exposures of a narrow stringer of fine-grained syenite porphyry cutting the pegmatite. Small inclusions of uraninite are said to have been found in these easterly openings, but none were seen by the writer.

Middle Pit.—This opening situated between the west and east pits represents the latest work done, and has been made on a discovery made in 1929. It lies 1,600 ft. east of the west pit and 400 ft. west of the easterly openings. Stripping operations were started here in the spring of 1929 on a small outcrop and have disclosed a well-defined lead that has been uncovered for a length of 150 ft. This lead is in pegmatite and parallels the strike of the dyke. Its full length has not yet been determined, but it outcrops again at a point 300 ft. east of the stripping and is exposed there for a width of 12 ft. It can also be traced for a short distance west of the stripping, but appears to be pinching out in this direction. It is probably safe to assume a total length of at least 500 ft. The width is greatest at the east outcrop, where it measures 12 ft. At the stripping, the greatest width is 8 ft. and the average about 5 ft., though there are several narrow horses of pegmatite in the east end. The above measurements relate to the width between the outermost exposed walls. The gneiss country rock is only visible

on the hanging-wall, the foot-wall being pegmatite. Insufficient stripping has been done on the foot-wall side to show whether any parallel leads exist, but this will be determined by the tunnel now being driven to tap the lead from a point 50 ft. down the slope below the outcrop. The dip of the lead at the surface is about 45° south, or into the hill, steepening to 70° at the bottom of a 20 ft. pit sunk near the west end of the stripping.

The lead occurs in pegmatite at its contact with the enclosing gneiss and seems to have the character of a longitudinal, miarolitic, cavity of unusual form and extent. Only a skin of pegmatite a few inches thick occurs on the gneiss hanging-wall and from it project numerous well-formed felspar crystals up to 6 in. in length. The foot-wall of the lead, as far as is visible, is also pegmatite, but there has been insufficient stripping to give any idea of the total width of the dyke here. The westerly 75 ft. of stripping shows a single lead, 5 to 8 ft. wide, but for the remaining 75 ft. the vein is split into four or five tongues of irregular width but ranging from 1 to 4 ft. These tongues are separated by narrow, 1 to 2 ft. horses of gneiss and pegmatite, the walls of which are also lined with felspar crystals. This part of the lead, therefore, represents a series of long, parallel, miarolitic, pockets or cavities, which toward the west run together into a single wider one. At the outcrop 300 ft. east of the stripping, where there is 12 ft. of lead exposed, there are no horses visible, the lead being uniform from wall to wall.

In its general character, the Richardson pegmatite resembles other pegmatitic bodies found in Cardiff and adjacent townships. As a type, these are quite distinct from the ordinary run of granite pegmatites so common in eastern Canada and are apparently peculiar to the Wilberforce district. The writer is inclined to view them as syenite, rather than granite, pegmatites, and to regard them as genetically related either to the nepheline syenite of the region or to the large batholithic masses that occur in Cardiff and Monmouth townships. These latter, it is true, are shown on Adams' and Barlow's map as granite, but in their report the writers note that the rock is never rich in quartz and often grades over into syenite.

A notable occurrence of another such pegmatite is found about one mile east of the Richardson property, where there is a large development of purple fluorite, mixed with calcite, apatite, hornblende, etc.; this deposit was worked at one time for fluorite. On the south-west end of the Richardson property, also, several small prospect pits were opened some years ago on fluorite outcrops. Another occurrence lies about 10 miles to the south-east, in Faraday township, where cavities in pegmatite contain calcite and enormous crystals of black mica, as well as large apatite crystals and fluorite. The writer has examined several other such deposits in the region, all generally similar in type. Some of them carry small traces of radioactive minerals, but none are in any way comparable in this respect to the Richardson deposit.

In their general character, these pegmatites possess a marked similarity with the mica and phosphate-bearing pyroxenites of the Ottawa district. These pyroxenites, which may be considered as basic counterparts of the Wilberforce syenite pegmatite, often contain large, irregular cavities lined with well-formed pyroxene crystals and carry a filling of calcite, in which are scattered large apatite and mica crystals; they do not yield radioactive minerals. The close structural similarity exhibited by these two rock types, and the fact that both often carry crystals of apatite and mica in a calcite filling of pockety cavities, provides strong evidence that the pyroxenites are of igneous, intrusive origin, rather than metamorphosed sediments as has often been believed.

The filling of the Richardson lead consists mainly of massive fluorite and calcite. Neither of these minerals was observed in the form of free crystals. Fluorite predominates in the greater part of the lead, but there are local enrichments of calcite, when the two minerals are present in about equal amounts: there is often an approach to banded structure. Scattered through this calcite-fluorite filling occur, in order of abundance, crystals of apatite, hornblende, magnetite, biotite, and uraninite.

At the outcrop, there has been considerable leaching of the calcite by surface waters, resulting in the formation of open cavities within the lead. These cavities contain a certain amount of dark reddish brown, earthy residue, and in this are often found loose crystals or lumps of uraninite.

From a search of the literature, the only recorded occurrence that in any way resembles geologically and mineralogically the Richardson ore-body appears to be a deposit at Wolsendorf, in Bavaria. At the latter locality, dark purple, fetid fluorite is found in a lead with autunite, torbernite, and uranophane, all alteration products of pitchblende, traces of which also occur.

Minerals of the Deposit.—Apatite.—Apatite occurs in considerable amount as free crystals in the calcite-fluorite matrix. The crystals are sometimes of considerable size, ranging up to 30 lb. in weight. Several dozen loose individuals were taken by the writer from a small pocket, the calcite of which had been leached out by surface waters. The prism faces are well developed, but good terminations are rare, the ends of the crystals seeming to have been attacked, and being pitted and rounded. There is apparently no development of compact, massive apatite. The colour is usually brownish green to brown or yellow. Like the apatite of other smaller deposits in the district, and in contrast to that of most pyroxenite deposits, the mineral is clear and glassy and exceedingly brittle. Clear fragments of considerable size and without visible flaws can often be picked from broken crystals.

An interesting feature of the apatite of the Wilberforce district is that where crystals exhibit terminal faces there is always a conspicuous development of the basal plane. This is sometimes so pronounced that the crystals appear to have almost square ends. The basal plane is seldom, if ever, found on the pyroxenitic apatite of the Ottawa region.

Biotite.—Biotite mica is stated to occur, sometimes in large plates, in the massive pegmatite of the west pit. It was not observed in noteworthy amount in the main, or middle pit.

Calcite.—Calcite is one of the principal constituents of the lead. It is mostly rather fine-grained and has a faint pinkish colour. As in the pitchblende veins of Czechoslovakia, the colour deepens to a brownish red in close proximity to uraninite nodules or crystals, and thus dark-coloured calcite serves as an indicator for uraninite.

Felspar.—Felspar, of a buff to reddish cast, is the principal constituent of the pegmatite with which the uraninite is associated. It is medium- to coarse-grained and probably is predominantly orthoclase (potash felspar). There is possibly a certain amount of soda or lime-soda felspar also present, but no information on this point, based on analyses or microscopic examination, is available. The walls of the miarolitic cavities in the pegmatite are lined with well-formed felspar crystals which often attain a length of several inches. This mineral always forms part of the pegmatite proper and it is not found as free crystals in the calcite-fluorite filling of cavities, as are the apatite, hornblende, magnetite, etc.

Fluorite.—As one of the principal constituents of the filling of cavities in the pegmatite, fluorite is possibly the most interesting gangue mineral present. When fresh, its colour is always of a dark reddish purple to violet shade, deepening in close proximity to uraninite to almost black. In this respect, it resembles the fluorite of other deposits of radioactive minerals throughout the world, and it may be taken as established that the dark colour is due to radioactive emanations. The colour of all such fluorites fades on exposure to light and the mineral eventually becomes colourless.

When disseminated through calcite, the fluorite is in the form of small shapeless grains. It also forms bands or stringers and is then usually fine-textured to dense and compact. The last type is always found in close association with uraninite, and thus serves as an indicator for that mineral. A peculiarity of such compact fluorite is that it gives off a strong odour when crushed or freshly-broken. This odour is of practical service to the workmen as an additional indication that they are breaking into a pocket of uraninite. The smell resembles that of ozone and is believed to be due to free fluorine.

The conspicuously dense texture and almost black colour of the fluorite accompanying the uraninite, and the reddish colour assumed by the calcite in similar association, would prove a useful aid in preliminary rough-sorting of the ore enabling the rich material to be readily separated in the pit from the lower-grade or barren gangue.

Hornblende.—Large, free crystals of hornblende, sometimes over 12 inches across, frequently occur in the calcite-fluorite filling of the main or middle lead.

Magnetite.—Magnetite is fairly abundant, occurring as large crystals or irregular masses in miarolitic calcite-fluorite. It was observed in greatest amount in the west and middle pits. It is frequently intergrown with uraninite, and sometimes also with apatite and hornblende.

Molybdenite.—Small traces of molybdenite are stated to have been found in the massive pegmatite of the west pit.

Uraninite.—This, as far as known, is the only radioactive mineral occurring in any important amount on the property. Small amounts of its alteration products, in the form of orange and yellow incrustations of uranium salts, as well as traces of torbernite, the copper uranium phosphate, are found in association with it, but these are hardly of commercial significance. Up to the present, none of the radioactive, rare earth minerals, not infrequently found in the ordinary granite pegmatites of eastern Canada, have been reported here.

The uraninite occurs as well-formed crystals and as nodular lumps. The crystals are often of unusual size, frequently measuring one inch or more across. They are of cubic habit, usually more or less modified by the octahedron. The lumps range from small individuals the size of a pea to masses weighing several pounds.

In the massive pegmatite of the west pit, the uraninite is stated to have been found chiefly associated with black mica and often enclosed in mica "books." Unlike its occurrence in the middle pit, it does not seem to occur here in miarolitic cavities. In the lead of the middle pit, the uraninite crystals and masses occur scattered through the calcite-fluorite filling, apparently without any regular system, but, as noted above, always in close association with dark purple fluorite. The same distribution holds at the outcrop 300 ft. east of the middle pit.

As regards the relative abundance of uraninite in the deposit, Mr. Bayeroft's report states that a sample taken across 30 ft. of pegmatite at the west pit yielded a little over one per cent U_3O_8, equivalent to 28·56 lb. uraninite per ton. The carload shipment sent to the Mines Branch, and representative of the ore of the middle lead, showed a recoverable uraninite content of 4·56 lb. per ton

Zircon.—Zircon is a minor rock-forming constituent of the pegmatite dyke, in which it occurs as small crystals measuring about $\frac{1}{8}$ by $\frac{3}{8}$ in. It appears to have rather a zonal distribution, being quite abundant in some parts of the rock while not visibly present in others.

Copper-Milling in New Mexico.—Concentrator practice at the Hurley plant of the Nevada Consolidated Copper Co., Hurley, New Mexico, is described by F. Hodges in Information Circular 6394 of the United States Bureau of Mines. The Hurley concentrator has a normal daily capacity of 13,500 tons of ore. For the first four months of 1930, heads averaged 1·32% copper. The recovery for this period was 83·98% and concentrates averaged 27·54% copper.

The ore as it comes from the mine at Santa Rita varies greatly in physical properties. The copper mineral is principally chalcocite, although this in places is accompanied by azurite, malachite, chrysocolla, and cuprite. The gangue minerals are quartz, pyrite, sericite, and halloysite. The concentrates contain approximately 0·040 ounce of gold and 0·55 ounce of silver per ton.

The concentrator consists of five departments, namely, coarse crushing, primary grinding, secondary grinding, flotation, and dewatering or filtering. The coarse crushing department of the concentrator consists of three units, each of which is equipped with one 34 in. feed conveyor, one 7 ft. Symons cone crusher, six Hum-mer screens, one 38 in. elevator, and one set of 72 by 20 in. Garfield rolls. The three units of this department are served by two 36 in. incline conveyors and two 28 in. shuttle conveyors for distribution of ore into the fine ore bins. The flow sheet of one unit of the coarse crushing department with accessory equipment serving the three units is given in the circular.

The primary and secondary grinding departments include nine sections, each with a normal capacity of 1,500 tons of ore per day. The flow sheet of one unit of primary and secondary grinding departments is also given.

The flotation plant is composed of eight rows of Southwestern air-lift matless rougher flotation

machines, each row having three cells, making a total of 24 rougher cells. Each two rows of rougher machines are served by one cleaner cell, with the exception of two rows which are used for experimental purposes. The combined classifier overflow products of all grinding sections are delivered to two flotation feed distributors. Each of these distributors serves one-half of the flotation plant and each splits its feed equally to four rows of flotation machines. A rougher concentrate is produced by the first cell and is pumped to a cleaner cell for finishing. The second and third rougher cells of each row make middlings products which are pumped to the distributors feeding the first rougher cell where they join the tailings of the cleaner machines, the total product being retreated with new flotation feed.

Air is furnished to the flotation cells by Roots blowers. The flotation reagents used at present consist of lime, raconite, and steam distilled pine oil. The lime is added to the rod and ball mill feeds in the form of milk of lime. The raconite mixture is manufactured at this plant. This reagent is added to the primary and secondary classifier overflow products of each section in the ratio of 50% to the primary product and 50% to the secondary product. The pine oil, Yarmor steam distilled, is added to the pump sumps receiving the middlings products of the rougher cells. The addition at these points is made to obtain greater emulsification by means of the middlings pumps before the reagent enters the flotation cells.

Flotation concentrates of the entire mill are delivered to one 48 by 20 ft. Dorr thickener by one 6 in. Wilfley pump. The overflow water of this thickener flows to one 75 by 20 ft. Dorr thickener, the clear overflow water from this second thickener being returned to the mill circuit. The concentrates pulp, thickened from 18·5% of solids to 70·0% of solids, is fed to 14 by 14 ft. Oliver filters. The filter plant contains five filters, four of the Oliver type and one Dorrco filter. The filter cake is conveyed to railroad cars.

The final tailings product, containing 21·7% of solids, is conveyed by gravity through a 30 in. diameter, continuous, wooden-stave pipe line a distance of 6,590 ft. to the settling ponds, the slope of the pipe line being 4·725 ft. per 1,000.

The settling pond now in service has a total area of 90 acres with an exposed water surface of 8 acres. Of the total water sent to the pond about 60% is recovered, the loss being due to water held with the tailings, to evaporation, and to a small amount of seepage. Clear water is reclaimed through one or more dewaterers located toward the central part of the pond and connected to a gathering pipe line on the natural ground under the deposited tailings. The dewaterers are constructed of 4 by 6 in. timbers laid flat, have an inside dimension of 4 ft., and are maintained at a sufficient height to give a clear overflow. The gathering line discharges by gravity into the main storage lake.

All samples are taken automatically with electric samplers which are governed by a master timer regulating their operation to one cut every eight minutes.

Various tables incorporated in the circular deal with screen analyses of coarse crushing-plant products, operating data for primary rod-mills, operating data for secondary ball-mills, screen analyses of primary and secondary grinding-mill feeds and products, screen analyses and distributions of copper in flotation products, distribution of electric power consumed, and filter plant data.

Top Slicing and Sublevel Caving.—Top slicing and sublevel caving methods in metal mining are discussed by Chas. F. Jackson in Information Circular 6410 of the United States Bureau of Mines. The paper deals more particularly with the application of these methods to the mining of iron ore in the Lake Superior region, where it is estimated that approximately twelve million tons of ore were mined by top slicing and six and one-half million tons by sublevel caving in 1929.

The author first discusses and illustrates these mining methods and their principal variations in an elementary way. Then their advantages and disadvantages, and the types of ore-bodies and conditions to which the methods are applicable are outlined. Descriptions of typical operations are given covering methods of developing for top slicing and sublevel caving, details of slicing and caving operations, timbering, covering down the floors and sides of slices before blasting down, including the use of wire fencing, handling and loading ore with power slushers, etc., with running comments on the various practices described.

Mining costs are next discussed and tables are presented showing: 1, the tonnage developed per foot of stope development and per foot of total development at 20 different mines; 2 and 3, direct mining costs per ton of ore hoisted at several typical mines; 4 and 5, distribution of costs in percentages of total mining cost; 6, labour costs in man-hours per ton; 7, explosive consumption in pounds per ton of ore mined; 8, timber consumption per ton, and 9, kilowatt-hours per ton of ore hoisted for all mining operations. Following these tables are notes briefly outlining the characteristics of the ore-bodies at each mine for which data are given in the tables.

Treadwell Yukon's New Concentrator.—The new all-flotation lead-zinc concentrator of the Treadwell Yukon Co., at Tybo, Nevada, is described by W. H. Blackburn in Information Circular 6430 of the United States Bureau of Mines. The ores treated are partly-oxidized complex mixtures of galena, sphalerite, marmatite, and pyrite (all argentiferous) in a siliceous gangue. The ore after crushing in a crusher set at 4 in. is reduced to $\frac{3}{8}$-in. in a cone crusher from which it goes to two ball-mills, each operating in closed circuit with a classifier. The classifier overflow, averaging about 5% plus 65 mesh and 69% minus 200 mesh, runs to the lead flotation system where it is treated in a 16-cell machine and a 3-pan pneumatic cleaner. The reagents used are soda ash, sodium cyanide, zinc sulphate, ethyl xanthate, and cresylic acid. The lead concentrates average about 60% lead, 4% zinc, and 87 oz. of silver per ton. The ratio of concentration is about 14 to 1.

The tailings from lead flotation flow to the zinc circuit which is equipped similarly to the lead circuit. Copper sulphate is used to reactivate the sphalerite which was depressed in the lead circuit. Other reagents used are hydrated lime, ethyl xanthate, and pine oil. The zinc concentrates contain about 47·5% zinc, 2·5% lead, and 14 oz. of silver per ton, and the concentration ratio is approximately 16 to 1.

The recoveries of silver, lead, and zinc range from 72 to about 75% and the total operating expense per ton of ore treated is approximately $1·28.

SHORT NOTICES

Strip Coal Mining.—O. E. Kiessling, F. G. Tryon, and L. Mann deal with the economics of strip coal mining in Economic Paper 11 of the United States Bureau of Mines.

Cut-and-Fill Stoping.—In *Engineering and Mining Journal* for May 11, Morris J. Elsing discusses the application of cut-and-fill methods of stoping.

Mining and Milling Tungsten Ores.—J. B. Huttl describes the underground and surface methods employed by the Tungsten Alloys Corporation at their mine near Tucson, Arizona, in *Engineering and Mining Journal* for May 11.

Explosion Measurement.—The accuracy of the manometry of explosions is discussed by C. M. Bouton, H. K. Griffin, and P. L. Golden in Technical Paper 496 of the United States Bureau of Mines.

Inflammable Gases.—H. F. Coward and G. W. Jones give some results of an experimental investigation into the limits of inflammability of gases and vapours in Bulletin 279 of the United States Bureau of Mines.

Crushed Stone.—In Economic Paper 12 of the United States Bureau of Mines, O. Bowles discusses the economics of crushed stone production.

Ore-Dressing.—Progress in ore-dressing during 1930 is discussed by Prof. H. Madel in *Metall und Erz*, 2 Maiheft.

Cyanidation.—In Technical Paper 494 of the United States Bureau of Mines, E. S. Leaver and J. A. Woolf describe the results of research into the effects of copper and zinc in cyanidation sulphide-acid precipitation.

Waelz Process.—The first part of an article, by W. E. Harries, describing the Waelz process as applied to complex copper-zinc-lead ores, appears in the *Canadian Mining Journal* for May 22.

Tadanac Smelter.—In *Engineering and Mining Journal* for May 11, G. J. Young describes the processes of lead smelting and zinc fuming at Tadanac, B.C.

Powder Analysis.—P. S. Roller, in Technical Paper 490 of the United States Bureau of Mines, describes a dynamic air-analyzer for fine powders and deals with the separation and size distribution of microscopic particles.

Stainless Metals.—In the *Journal* of the Royal Society of Arts for May 8 the text is given of an address on stainless metals by Sir Harold Carpenter.

Metallography.—Technical Publication No. 421 of the American Institute of Mining and Metallurgical Engineers contains the text of the Howe Memorial Lecture given by F. F. Lucas, the subject being "On the Art of Metallography."

Lead Determination.—The determination of lead as chromate in presence of perchloric acid is described by D. J. Brown, J. A. Moss, and J. B. Williams in *Industrial and Engineering Chemistry* for April 15.

Calcium-Magnesium Separation.—R. C. Wiley describes the separation of calcium and magnesium by a molybdate method in *Industrial and Engineering Chemistry* for April 15.

Tavistock Theodolite.—An article describing the Tavistock theodolite appears in *Engineering* for May 29.

Electromagnetic Absorption by Rocks.—J. Wallace Joyce discusses electromagnetic absorption by rocks and gives some experimental observations taken at the Mammoth Cave, Kentucky, in Technical Paper 497 of the United States Bureau of Mines.

Mineral Industry of Indo-China.—In *Revue de l'Industrie Minerale* for May, M. F. Blondel discusses the mineral development of Indo-China.

Tin in Bolivia.—The tin ores of Unsia-Wallagua, Bolivia, are described by F. Ahlfeld in *Economic Geology* for May.

Geneva Lake Lead-Zinc Deposit.—R. Tuck describes a lead-zinc deposit at Geneva Lake, Ontario, in *Economic Geology* for May.

"Red-Bed" Copper.—In *Economic Geology* for May, E. B. Papenfus describes "red-bed" copper deposits in Nova Scotia and New Brunswick.

Diatomite.—A short paper on diatomite by V. L. Eardley-Wilmot, writer of a memoir of the subject, appears in the *Canadian Mining and Metallurgical Bulletin* for May.

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.*

1,026 of 1930 (346,404). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Strontium oxide is prepared from the moist carbonate by calcination in a rotating furnace.

1,344 of 1930 (346,674). J. W. Hinchley, London. Lead hydrate dissolved in a solution of caustic alkali is used in a cyclic process for de-tinning scrap metal.

4,869 of 1930 (345,431). A. Dawans, Liège. Ores are roasted and agglomerated in a furnace having a movable bed-plate on which fusion is effected, this bed being displaced at an equal speed and in the opposite direction to the propagation of combustion.

6,531 of 1930 (346,921). I. G. Farbenindustrie, A.-G., Frankfort-on-Main, Germany. The apparatus for use in the reduction of metal halides is made of metal, provision being made for those parts which come in contact with hydrogen halide to be kept hot.

19,724 of 1930 (345,902). I. G. Farbenindustrie A.-G., Frankfort-on-Main, Germany. Beryllium minerals are treated with gaseous hydrogen fluoride at temperatures above 100° C., the beryllium fluoride being recovered by water washing.

1,724 of 1931 (345,351). C. Goetz, Berlin. Simple concentration or leaching methods are found to be applicable to ores which have been heat treated in the presence of a hydrocarbon and in the absence of air.

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

Guide to the Study of Non-Metallic Mineral Products (Except Building Stones). By W. S. Bayley. Cloth, octavo, 530 pages, illustrated. Price $4. New York: Henry Holt.

Power and the Internal Combustion Engine. By W. E. Dalby. Cloth, octavo, 280 pages, illustrated. Price 18s. London: Edward Arnold.

World Survey of the Zinc Industry. By W. R. INGALLS. Paper covers, 128 pages. Price $2.25. New York: Mining and Metallurgical Society of America.

Catalogue of Plans of Abandoned Mines. Vol. V. Paper covers. Price 15s. London: H.M. Stationery Office.

Canada: Report of the Department of Mines for year ended March 31, 1930. Paper covers, 61 pages. Price 25 cents. Ottawa: Department of Mines.

Mineral Industry of Canada: Investigations of Mineral Resources and the Mining Industry, 1929. Paper covers, 69 pages, illustrated. Ottawa: Department of Mines.

Niagara Falls Survey, 1927. By W. H. BOYD. Memoir 164 of the Geological Survey of Canada. Paper covers, 15 pages, with many plates and maps. Price 10 cents. Ottawa: Department of Mines.

Geological Survey of Canada. Summary Report, 1929, Part B. Paper covers, 202 pages, illustrated. Ottawa: Department of Mines.

Natal: The Geology of the Country Surrounding Nkandhla, an explanation of Sheet No. 109 (Nkandhla). By Dr. A. L. DU TOIT. Memoir of the Geological Survey of South Africa. Paper covers, 105 pages, illustrated. Price 5s., including map. Capetown: Government Stationery Office.

Tanganyika Territory: Land Development Survey, 3rd Report, 1929–30. Uluguru Mountains, Eastern Province. Paper covers, 21 pages, with map. Price 2s. 6d. London: Crown Agents for the Colonies.

Nitrate Deposits in South-Eastern California, with notes on deposits in South-Eastern Arizona and South-Western New Mexico. By L. F. NOBLE. United States Geological Survey Bulletin 820. Paper covers, 108 pages, illustrated. Price 45 cents. Washington: Superintendent of Documents.

Montana: Geology of the Big Snowy Mountains. By F. REEVES. United States Geological Survey Professional Paper 165–D. Paper folio, with maps. Price 20 cents. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1929. Part 1, pp. 179–201, Secondary Metals, by J. P. DUNLOP; pp. 203–229, Chromite, by L. A. SMITH; pp. 231–264, Lead, by E. W. PEHRSON. Washington: Superintendent of Documents.

Rhodesian Manual: Agriculture, Industry, Mining. Edited by C. CARLYLE-GALL. Cloth, 1,022 pages, illustrated. Price 21s. London: Mining and Industrial Publications of Africa.

Official Year Book of the Scientific and Learned Societies of Great Britain and Ireland. Cloth, octavo, 384 pages. Price 18s. London: Charles Griffin and Co.

COMPANY REPORTS

Lonely Reef Gold.—This company was formed in 1910 to acquire the Lonely Group claims, north of Bulawayo, Rhodesia. The report for the year 1930 shows that 71,900 tons of ore was milled, yielding 33,354 oz. of gold, as compared with 37,163 oz. from 63,300 tons in the previous year. The revenue from gold was £141,658, against £158,221, but costs show a decrease from £95,813 to £82,974, the working profit being only £3,724 lower at £58,684. In addition to the treatment of current ore, the treatment of accumulated slimes has now been in progress for the last 3 years, the amount treated in 1930 being 183,900 tons which yielded 12,591 oz. of gold, worth £53,466, at a cost of £18,925. The accumulated slimes were originally estimated to amount to 900,000 tons and, of this amount, 513,700 tons have now been treated. The total profit on the year's working was £96,813, of which £57,860 was distributed as dividends, equal to 20%. The ore reserves at the end of the year were estimated to be 49,125 tons of an average value of 12·9 d.w.t., a reduction of 23,836 tons when compared with the previous year, but the marked reduction in working costs will, it is estimated, bring large bodies of low-grade ore within reserve limits.

Associated Tin Mines of Nigeria.—This company was formed in 1926 to work alluvial tin properties in Nigeria. The report for the year 1930 shows that 1,990 tons of concentrates was recovered, the cost per ton at Bukuru being £60 9s. 7d., as compared with £82 8s. 3d. in the previous year. The average price realized for the concentrates was £99 8s. 2d., against £142 9s. 11d. the year before. The fall in output from 3,062 tons to its present figure represents the measure of restriction adopted in pursuance of the policy of the Tin Producers' Association. The net profit for the year was £29,426, which was added to the balance of £98,372 brought in, making an available total of £127,797. After making provision for depreciation of plant and machinery, the balance of £93,845 was carried forward. Owing to the curtailment of production, some of the European staff was transferred to prospecting work, with the result that a large tonnage of ore was added to the reserves, which are now estimated to be 33,579 tons. The erection and installation of four electrically-driven 12 in. gravel and 14 in. nozzle pumping plants, mounted on pontoons, was completed during the year and are stated to be giving good results.

Naraguta Karama Areas.—This company was formed in 1926 and works alluvial tin properties in Northern Nigeria. The report for the year 1930 shows that 309½ tons of tin concentrates was produced, against 311 tons in the previous year, the average price realized being, after allowance for freight and smelting charges, £74 9s. 4d., which compares with £117 5s. 11d., in the previous year. The profit for the year, after allowing for depreciation, was £1,909, which was carried forward. The property in Nigeria has, in view of the tin position, been placed in the hands of a skeleton staff.

Kagera (Uganda) Tinfields.—This company, formed in 1926, operates a tin property at Mwirasandu, Uganda. The report for 1930 shows that 329 tons of tin concentrates was produced during the year, as compared with 312 tons in the previous year. The output realized £28,249 after deducting smelting and realization charges, the average price per ton being £85 17s. 3d., as compared with £133 5s. the year before. The year's working showed a loss of £6,187, against a profit of £7,622 in 1929, and a debit balance of £6,043 is carried forward. It is estimated that the new plant in course of erection at the mines will enable a larger tonnage to be handled at reduced cost. As in the previous year, the estimate of mine ore reserves has been found to be difficult, but is given as 365 tons of tin oxide, while the detrital reserves are estimated at 1,511 tons.

Cape Asbestos.—This company, formed in 1893, operates asbestos properties in Griqualand

West and is interested in other properties in the Lydenburg district of the Transvaal and Italy. The report for the year 1930 shows that the company's sales of raw materials and manufactured goods were seriously affected during the year, the profit being reduced from £39,382 to £26,211. Dividends on the preference shares absorbed £12,500 and a dividend of 5% on the ordinary shares £6,250, the balance carried forward being £21,165. The blue asbestos mines in South Africa were working to capacity throughout the year, but the demand for amosite was poor.

Sons of Gwalia.—Originally formed in 1898, this company works a gold mine in Western Australia, the general managers being Messrs. Bewick, Moreing. The report for the year 1930 shows that the mill treated 116,390 tons of ore and 39,504 tons of accumulated sands and slimes, the total output of gold being 38,225 oz., which realized £162,353, to which must be added the exchange premium of £12,057. Compared with the previous year the ore was of better grade, but the tonnage treated slightly lower. The gross profit for the year under review was £17,797, which wipes out the debit balance from the previous year and leaves a balance of profit of £8,111 to be carried forward.

Boulder Perseverance.—This company was formed in 1923 as a reconstruction of Great Boulder Perseverance, which was formed in 1895 to work a gold mine at Kalgoorlie, Western Australia. The report for the year 1930 shows that 69,191 tons of current ore, 6,056 tons of ore from outside sources, and 4,072 tons of tributor's ore was treated in the mill, producing 42,112 oz. of gold and 9,219 oz. of silver, the output realizing £178,930. The mine profit was £14,858 and, after allowing for development expenditure and other charges, there was a net profit of £533, which reduces the debit balance brought in to £2,104.

Associated Northern Blocks (W. A.).—This company was formed in 1899 to acquire mining leases in the Kalgoorlie district of Western Australia. The report for the year 1930 shows that operations on the Gimlet leases ceased at the end of 1929, the mill clean-up yielding bullion worth £535. On the Iron Duke lease, the tributors raised 455 tons of ore which realized £720 9s., the royalty being £8 7s. 6d. The results for the year show a debit of £1,479, which reduces the credit balance to be carried forward to £1,720.

Tanjong Tin Dredging.—This company was formed in 1926 to work alluvial tin property in the Kinta district, F.M.S. The report for the year 1930 shows that an area of approximately 9½ acres was dredged, the yardage treated being 1,061,030 cu. yd. and the tin concentrates recovered amounted to 324 tons. The total revenue was £30,512 and the working profit £12,232. After meeting all charges there remained a net profit of £4,955 and £4,000 was distributed as a dividend, equal to 5%. The carry forward has been increased from £3,234 to £4,189.

Kinta Tin.—Formed in 1900 this company works alluvial tin properties in the F.M.S. The report for the year 1930 shows that 1,016,700 cu. yd. of ground was treated, yielding 289 tons of tin concentrates, the total revenue being £24,809. The yardage treated showed an increase of 54,200 cu. yd., but owing to a restriction policy the output of concentrates was 80 tons less. The working profit was £8,918 and, with the balance brought in, there was an available total of £28,414. A dividend of 5% absorbed £6,000 and £2,611 was written off the Sinju pipe-line, leaving a balance of £19,804 to be carried forward.

Fabulosa Mines.—This company was formed in Bolivia in 1921 and operates groups of tin mines in that country. The report for the year 1930 shows that 1,139 tons of fine tin was produced at an average cost of £132 1s. 11d. per ton, the year's working showing a loss of £18,803. The Fabulosa property is carrying on on a small scale, but the Milluni property was closed down in the middle of the year. The Union property continues to improve, partly owing to the high-grade ore being worked in the Carmen mine and the increased efficiency of the concentrator.

South Crofty.—This company was formed in 1906 and owns a tin mine between Camborne and Redruth. Crushing was stopped in October last. The report for the year 1930 shows that up to the stoppage of the mill the ore crushed amounted to 60,273 tons, the tin recovered amounting to 670 tons, which realized £59,558. In addition, 239¾ tons of arsenic oxide was recovered, realizing £4,113. The production of wolfram from the Castle-an-Dinas property was continued, the profit for the year being £2,964. The year's working resulted in a deficit of £6,378, met by transfer from reserve. The mine is being kept free of water and the plant in running order and it is intended to recommence crushing when tin recovers to £140 per ton.

DIVIDENDS DECLARED

Chosen Corporation.—3¾d., less tax, payable July 15.

Henderson's Transvaal Estates.—5%, less tax.

Kaduna Syndicate.—4½d., less tax, payable June 30.

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

Lonely Reef.—2s., less tax, payable July 31.

Malayan Tin Dredging.—1½d., less tax, payable June 19.

Mount Lyell.—6d., less tax, payable June 29.

Southern Malayan Tin Dredging.—1½d., less tax, payable June 18.

Vereeniging Estates.—1s., less tax, payable July 30.

Zinc Corporation.—Pref. 2s., less tax, payable July 2.

NEW COMPANIES REGISTERED

East Cornwall Wolfram Syndicate.—Registered May 20. Nominal Capital: £1,000. Objects: To carry on the business of miners and prospectors, etc.

Northern Nigerian Lead Mines.—Registered May 18. Nominal Capital: £20,000 in 5s. shares. Objects: To acquire any mines, mining rights, etc., in any part of the world; to acquire leases of mines in Nigeria, and to enter into agreements with J. L. Crozier and the British (Non-ferrous) Mining Corporation, Ltd. Office: 73–76, King William Street, E.C. 4.

Stefano Syndicate.—Registered May 11. Nominal Capital: £25,000 in 5s. shares. Objects: To acquire mining and other rights, and to adopt an agreement with E. J. Clay. Directors: A. F. Hollis and H. A. F. Ellinghouse. Office: 7 Garrick Street, W.C.2.