The Mining Magazine

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EDITORIAL

QUEER things have been found from time to time in treatment plants, but whether the eel which was brought up by a suction dredge and ultimately found itself, after a peregrination through the tin-dressing plant, on a James table can claim to be a pioneer may be open to question. It is certainly a fishy story, and we are assured it is a true one.

DURING his life time Mr. William Thomas was a prominent figure in Cornish mining and his connexion with the Cornish Institute of Engineers and the Camborne School of Mines will recall grateful memories. The institute feels that his name should be perpetuated by some tangible memorial and subscriptions are invited for this purpose, the form of the memorial depending on the amount forthcoming.

ELSEWHERE in this issue Mr. Hugh Picard draws attention to the increased demands that are being made on the benevolent fund of the Institution of Mining and Metallurgy. His appeal will commend itself to mining companies, as well as to those members of the profession who are in a less unfortunate position, and it is to be hoped that it will meet with the response which it deserves. All subscriptions sent in response to Mr. Picard's appeal will be acknowledged in THE MINING MAGAZINE.

THE teaching of geology at Edinburgh University has long been hampered by the lack of adequate accommodation, a state of affairs which was remedied last month, when the new Grant Institute of Geology was opened by the Prime Minister. There was a distinguished gathering at the opening of the new building, which has been erected on the southern edge of the city, adjacent to the other departments housed in post-War buildings. The institute has been provided by Sir Alexander Grant, who gave £50,000 for the purpose.

LECTURING at the Royal Society of Arts this month on geophysical methods of prospecting Mr. A. Broughton Edge was able clearly to define just what the qualified geophysicist can do. He cannot locate an ore-body directly, but he can locate a ground anomaly, and it remains for the mining geologist to report on the likelihood of such an anomaly possessing any economic significance and for the prospecting drill to prove it. It is probable that the science of geophysics—for it is becoming a very exact science—would be in better favour with engineers if this limitation of its sphere of usefulness was more generally appreciated.

Industrial Research

The conditions prevailing in the present-day world, when scientific aid to industry is of such vital importance, tend nevertheless to restrict the prosecution of research by private enterprise, solely for lack of means. It is, therefore, fortunate that the machinery exists in this country whereby the Government can follow the main lines of research along which the most progress seems probable, guarding the country in this way against any chance of retrogression. The work which is carried out under the supervision of the Department of Scientific and Industrial Research has just such an aim in view, the report [1] of the advisory council for the year 1930–31 containing an admirable summary of its activities. It is well, in addition, to emphasize the wide view which is taken of the whole problem of scientific and industrial relations by the council, which fully realizes that its main endeavour must be to encourage industry to look upon research as an essential part of the business of production and not as a last resource. The view of the department is that industrialists are becoming increasingly anxious to take advantage of applied science and if it is the fact that industry realizes at last that in the development of up-to-date and progressive methods of manufacture lies its own salvation the resulting co-operation with science is heartily to be welcomed. This growing contact cannot but help the industrialist and it will serve also to keep his scientific brother conversant with modern commercial needs. As mentioned in the report, it has been said by Sir Robert Hadfield that it took his firm 21 years to develop the use of transformer steel from the experimental stage to the

[1] Report of the Department of Scientific and Industrial Research, 1930–31. H.M. Stationery Office. Price 3s.

manufacture of the commercial article, a striking illustration of the type of slow, painstaking research which is now best undertaken by the department. One further point should, perhaps, be emphasized before proceeding to a short review of some of the department's activities. It is generally realized that new industries are rarely created as a result of direct scientific attack on a given problem, since they can usually be traced to relatively remote origins. Nevertheless the careful investigation of new devices might often with advantage be entrusted by interested industry to the care of the department.

The work carried out in the metallurgy department of the National Physical Laboratory is mainly concerned with the physical structure of metals and alloys, although the provision of special refractories for various purposes is also one of its functions. Passing on to the activities of the Fuel Research Board, one of the most important tasks is the continuation of the physical and chemical survey of the national coal resources, the local laboratory at Leeds, to serve the West Yorkshire coalfield, having been completed during the year, and the Birmingham laboratory is now being equipped. The study of the action of various catalysts has formed the main line of work on the hydrogenation of coal, but a report has been published which gives details of experiments showing how the caking properties of certain coals can be modified by treatment with hydrogen under pressure. An interesting feature of the research on the cleaning of coal is contained in the announcement that the board has acquired an Elmore vacuum flotation plant for the separation of mineral impurities from fine coal. As regards the Geological Survey of Great Britain, its activities during 1930–31 have already been noticed in these columns, but the increasing use which has been made of the survey by those responsible for some of the major construction works at present being undertaken in this country is well worthy of notice. Work carried out at various points for the Metallurgy Research Board has included investigations into the behaviour of metals at high temperatures—several improved alloys have been developed—the testing of light alloys, the manufacture of pure beryllium, researches on steel castings, ingots, and alloy steels, the cracking of boiler plates, inclusions in steel, as well as work on the problems connected with the electro-deposition of metals. Turning to geophysics, the scheme for financial aid to the Imperial College in the foundation of a school of applied geophysics is awaiting final acceptance by the governing body of the college, but meanwhile investigations are being continued by Professor Rankine into seismic methods and the development of the Bieler-Watson electrical method, while at Cardiff electrical methods are being tested for the purpose of the detection of water-logged areas in coal-mining. Lastly, the work of the British Non-Ferrous Metals Research Association should be mentioned. The research programme of this body has been fully maintained during the year, many metallurgical investigations being in hand.

Much of the work which has been reviewed here may at first sight seem to be of little interest to the mining man, so much of it being devoted to the application of metals to new industrial processes. It will, however, readily be granted that the restricted outputs of the base metals can only be expanded as increasing use is found for them in industry and it is as well, therefore, that members of the profession should be aware that this important item among those contributing to their future welfare is provided for.

Gold on the West Coast

When this country left the gold standard the price of the metal in those colonies whose currency is linked with sterling instantly commanded a premium, which forthwith encouraged an active search for new mines. The Gold Coast was naturally one of the first to attract attention. The intense activity which prevailed in this corner of the Empire during what was called the "jungle boom," when so many mines were opened which were doomed to failure from one cause or another, will be well remembered by those who have been for any length of time associated with mining. Some of the causes which then militated against success, however, no longer exist, notably the disadvantages of high transport charges and the difficulties prevalent in a country covered with tropical vegetation, with a climate none too favourable for the white pioneer. Under the changed conditions it was only to be expected that the gold deposits of the West African coast would once again loom large in the public eye and it was fortunate that they should receive the timely and authoritative publicity afforded last month

by Sir Albert Kitson—for many years director of the Gold Coast Geological Survey—in his address to the fellows of the Royal Empire Society on the gold resources of the colony.

In the course of his review Sir Albert recalled that the records showed that the first gold from the colony reached England as far back as in 1555, but it was not until 1878 that the first European company was formed to work a concession at Tarkwa, although this was quickly followed by many others. During the intervening three centuries activities seem to have been almost entirely confined to the natives. Between 1878 to 1903—the period of the "jungle boom"—Sir Albert considered that at least £43,000,000 in precious metal must have been exported, and even this figure is probably an underestimation. From 1903 to the end of 1931 an additional 7,056,000 oz. of fine gold was exported, its value being, perhaps, another £30,000,000, bringing the total for the years 1878 to 1931 up to £73,000,000, the three main sources being the reef mines of the Tarkwa-Abosso banket field, the quartz-lode mines—such as those of Ashanti and Prestea—and the alluvial deposits of the Ankobra, Offin, Pra, and Birim Rivers, the greater portion of the gold won during the centuries of native activity having undoubtedly been obtained from the last-named type of deposit. The colony would certainly seem to be well deserving of its name, gold being widely distributed over 10,000 square miles of country in quartz veins, banket, pegmatite dykes, and stream and beach gravels and sands. Sir Albert Kitson is of the opinion that the failure of the dredging industry was largely due to the use of unsuitable plant, difficulties with water-logged and drifted timber, rocky bars across the rivers, and incompetent management, which often resulted in the theft of gold and amalgam from the dredges, accidents to the dredges themselves, and disregard of proper health precautions. Nevertheless, it is evident that much alluvial gold still remains in locations which will some day be profitably worked, and in this connexion mention should be made here of a useful bulletin of the Geological Survey,[1] wherein references are given to those occurrences of gold and other economic minerals which have been recorded in the annual reports of the director. Turning to the banket mines, Sir Albert considers the high mining costs of pre-railway days to have been the main cause contributing to the failure of the early ventures and he drew attention to the recent work of Dr. N. R. Junner and Mr. O. A. L. Whitelaw on this deposit, these workers considering that there is now promise of the re-opening of some of the old mines and the development of new ones on the western limb of the Tarkwa syncline. As regards the third type of deposits—the quartz veins—reference to the various bodies located by the Survey will be found in the bulletin already referred to. Finally, in view of the present depressed conditions in the cocoa industry, Sir Albert pointed out that the available labour supply in the colony is now considerable and that increased attention to mining would be welcomed by the Government.

In giving consideration to the attractions offered by mining conditions on the Gold Coast, it must be remembered that prospecting is already being actively prosecuted there and, provided favourable locations are discovered, they are likely to be rapidly developed. Nevertheless, the auriferous country is extensive and prospecting, suitably aided by those facilities a good government alone can provide, should prove a boon to professional men at a time when depression tends to hit them hard, and should eventually lead to the development of profitable enterprise and the provision of supplies of a metal the world badly needs.

[1] Bulletin No. 5, Gold Coast Geological Survey. Crown Agents for the Colonies.

A Welsh Drainage Tunnel

It is somewhat unusual for speed records in mining work to be created in this country, where metal mining enterprises have seldom justified a scale of operations in which record breaking might reasonably be expected. During the past few months, however, we have had occasion to report various new European tunnelling achievements, notably at Halkyn, in Flintshire, where a drainage scheme is being developed with the object of opening up an old lead-zinc area to such greater depths as will render cheap mining possible; at Haweswater, where work in connexion with the Manchester Corporation's water supply is under way; and in Yugoslavia, at the Stantrg mine. All these enterprises are under British control and we have felt some pride in recording the results that have been obtained, but have eagerly

awaited, along with all mining men, more actual details of the methods employed. More than usual interest was, therefore, aroused by the announcement that the paper to be read at the January meeting of the Institution would deal with one of these three projects, a good number of members being present to hear the introduction of a paper by Messrs. J. L. Francis and J. C. Allan on " Driving a Mines Drainage Tunnel in North Wales," which was concerned with the Halkyn scheme. Mr. Francis was unable to be present and the subject was introduced by Mr. Allan, many of those present joining in the interesting discussion which followed.

Elsewhere in this issue will be found full extracts from the paper, but it will be as well to give here some idea of the scope of the work which has been undertaken in the Halkyn district and, in addition, a summary of the means by which it is being carried out. As is well known, a mining industry—at times a prosperous one—has been carried on in the Halkyn and Llanarmon areas of North Wales since ancient times and the discovery of pigs of Roman lead might be offered as evidence of antiquity. The mineralized area occurs in Carboniferous limestone country, the limestone series overlying the Silurian and being in turn overlaid by coal measures dipping gently east. Fissures in the limestone, running east and west, have been extensively mineralized, as also, but to a less extent, have the cross-courses, which run north and south. The authors show that the history of mining in this area has been one of constant struggle against the heavy water encountered and various drainage schemes have been suggested which would do away with excessive pumping costs at comparatively shallow depths. The earliest of these schemes was started in 1818 and consisted of an adit driven at about 170 feet above O.D. This adit was continued by the Halkyn District Mines Drainage Company of 1875 for a total distance of about five miles, the mining industry in the neighbourhood receiving great stimulus thereby. A later project, started in 1897, included the driving of a sea-level tunnel from Bagillt, on the estuary of the Dee, having in view the drainage of the mines in the Holywell or northern area. Prior to the War, when the mines were approaching the 170-foot tunnel level, the output of the district showed a serious decline and it was decided to extend the Holywell-Halkyn tunnel. The present work is a continuation of this project and it has only been made possible, after long negotiations, by an amalgamation of the many interests in the district. Work commenced in the spring of 1928, when complete investigations into modern tunnelling practice were made, as it was realized by those concerned that the available capital would justify a certain expenditure per foot, the idea being to obtain the maximum speed commensurate with such a cost. It was well understood that the three main operations involved in tunnel driving are the breaking of the ground, the removal of the spoil, and the transport of broken rock to the dump. A study of the authors' results shows how carefully these operations have been co-ordinated in the course of their work, but it also clearly demonstrates how important has been the effect of the introduction of the mechanical scraper in shortening the time taken to clear away broken ground. Mr. Allan's introduction did full justice to the excellent work of his colleague and himself and he showed conscious pride in the fact that such good results had been achieved with British labour.

The discussion was opened by Mr. R. E. Palmer, who emphasized the important speed-cost relationship which had been noted by the authors, showing that there was a limit to the speed which could be obtained on a particular project without increasing costs. The choice of scraper mucking was, in Mr. Palmer's opinion, almost a necessity in a tunnel of the dimensions in question, as a machine could hardly operate in such a space, although we understand that a shovel was used for the purpose in the Yugoslavian tunnel already referred to. Mr. Palmer then gave a detailed comparison of the results in the Halkyn tunnel with those obtained before the War on one in Alaska and showed how little the speed of two of the major operations—the breaking of the ground and its transport to the dump—had been improved, but what a difference mechanical mucking had made. Colonel Edgar Pam, who followed, commented on the number of holes used in the blasting round and was disposed to consider that the use of a hole-director might cause saving in this respect, although it was subsequently stated by the author that, owing to the toughness of the limestone, the standard round shown in the paper had proved the best. Several other speakers joined in the discussion, the interest shown bearing ample testimony to the practical value of the work described.

REVIEW OF MINING

Introduction.—Conditions in the mining world show little change and it is generally felt that some settlement of war debt problems and the reparations question must precede any material improvement in trade. Meanwhile international relations have not been helped by the continued struggle in the Far East.

Transvaal.—The output of gold on the Rand for January was 890,688 oz. and in the outside districts 46,096 oz., making a total of 936,784 oz., as compared with 923,353 oz. in December. The number of natives employed on the gold mines at the end of the month totalled 215,752, as compared with 211,552 at the end of December.

Shareholders of Brakpan Mines, Ltd., and of Witpoort Gold Areas, Ltd., were informed last month that a provisional agreement between the two companies had been entered into, whereby all the assets of the latter are to be sold to Brakpan Mines for £200,000 in South African currency, payable in four six-monthly instalments of £50,000 each, the first becoming due on June 30 next. An extraordinary meeting of Witpoort Gold Areas is to be held at an early date, at which the shareholders will be asked to confirm the agreement, provisional consent to which has been obtained from the Union Minister of Mines and Industries. Meanwhile the Brakpan company has resumed the developments on the Witpoort areas which were suspended in November last.

The quarterly reports of the companies of the Anglo American group for the three months ended December 31 last show that the crushing plant at Daggafontein Mines was put into commission on December 31, milling starting on January 2, the whole plant, it is stated, functioning smoothly and well. The first return, published at the end of January, states that operations were initially only on a small scale and that there was a certain amount of absorption of gold in the plant, the figures showing a total of 21,000 tons treated for a recovery of £13,556. The ore reserves at Daggafontein at the end of 1931 were estimated to be 2,003,174 tons, averaging 8·09 dwt. over a stoping width of 44·16 in.

The accounts of the Rand Selection Corporation, Ltd., for the year to September 30 show a profit of £150,383, which, with the sum of £102,713 brought in from the previous year and £12,500 transferred from premium on shares account, gave an available total of £295,596. Of this amount £3,068 has gone for taxation purposes and £200,000 has been written off the value of shareholdings, leaving a balance of £92,528 to be carried forward. No dividends were paid during the year, it being considered in the best interest of the corporation to conserve its resources.

Shareholders of Potgietersrust Platinums have been informed that Rustenburg Platinum Mines, in which the company is largely interested, has decided, in view of the large stock of platinum on hand and the recent falling off in sales, temporarily to suspend production.

Diamonds.—The report of the Premier (Transvaal) Diamond Mining Co., Ltd., for the year ended October 31 last shows a further considerable decrease in diamond sales, which at £278,403 compare with £685,980 for the previous year. In consequence of this the accounts show a loss of £190,241, which has been met from the trading fund of £400,000, in which the Union Government has a 60% interest, the carry forward being increased from £28,669 to £58,281. Although this amount would have been sufficient for the payment of preference dividends, no declaration was made during the year, it being considered advisable to conserve the company's resources. A total of 3,350,779 loads was hauled from the mine, the diamond production amounting to 604,217 carats, a decrease of 96,726 carats as compared with the previous year. The curtailment of operations to daylight work only has enabled the management to concentrate upon the removal of the blocks of blue ground adjacent to the rim rock, which were left unworked in the upper levels. The quantity of blue ground in sight above the 610-ft. level is estimated at 11,000,000 loads.

Rumours that De Beers were contemplating closing down owing to the flooding of the market with illicit diamonds, the forced sale of government stones, and the re-opening of the inland district of Namaqualand were authoritatively denied last month. It is stated that the company is continuing operations on the restricted scale at present in force, although early in the present month Sir Ernest Oppenheimer warned the Union Government that unless necessary remedies were speedily adopted he expected that all South African diamond mines would be closed down by March.

Southern Rhodesia.—The output of gold from Southern Rhodesia during December was 50,034 oz., as compared with 44,516 oz. for the previous month and

46,485 oz. for December, 1930. The complete figures for 1931 show a total yield of 532,111 oz., worth £2,273,875, as compared with 547,630 oz., worth £2,316,649, in 1930. Other outputs for the month of December were : Silver, 8,686 oz. ; coal, 50,785 tons ; chrome ore, 4,371 oz. ; asbestos, 777 tons ; mica, 619 lb.

Northern Rhodesia.—At an extraordinary meeting of shareholders of Roan Antelope Copper Mines held this month it was resolved that the nominal capital of the company should be increased by £250,000 to £1,750,000, by the creation of an additional 1,000,000 new shares of 5s. each. The new shares have been offered to shareholders and holders of option certificates in the proportion of one new share for each six shares held or under option, the issue price being 7s. 6d. per share. The proceeds of the issue are to be used for the reduction of the amount of advances required to finance copper in transit and for general purposes.

A circular to shareholders of Luiri Gold Areas, Ltd., gives some details of the results of development work on the old Dunrobin reef and also indicates the position of the new reef, which was discovered in the course of development on the 2nd level of the old one. Work on the new reef shows that it is a new ore-body running more or less at right angles to the old and that it is of lower grade, although much wider. It is stated that reports to date show the new ore-body to average 8 to 10 dwt. in value over a width of 15 to 20 feet.

Gold Coast.—In the last issue of the MAGAZINE the proposal of the Ashanti Goldfields Corporation once again to capitalize £125,000 of the reserve fund was announced and at the annual meeting held last month this proposal was approved. The report for the year to September 30 last shows that 142,910 tons of ore was treated for a yield of 169,245 oz. of gold and 10,441 oz. of silver, 116 oz. of gold being recovered in addition from sundry sources, metallurgical extraction being equivalent to 93·2%. The working profit for the year was £525,467 and the net profit £422,509, of which £337,500 was absorbed as dividends, equal to 90%. The ore reserves in the Ashanti mine at September 30 were estimated to be 667,400 tons of an average value of 23·1 dwt., an increase of 59,800 tons in amount and a decrease of 1·6 dwt. in value when compared with the previous year.

In the report of Bibiani (1927) for the year ended September 30, 1931, it was shown that it was proposed to increase the nominal capital of the company to £400,000 by the creation of 1,500,000 new shares of 4s. each and to issue 750,000 of these shares forthwith. The proposal was approved at the annual meeting held last month, the manner in which the new capital is to be used having been indicated in the last issue of the MAGAZINE.

Nigeria.—The accounts of Anglo-Continental Mines for 1931 show a profit of £6,503, which, added to the balance of £45,150 brought in from the last account, gave an available total of £51,653, which has been transferred to reserve and deducted from the value of investments, which now stand at £149,110.

Uganda.—A circular to shareholders of Kagera (Uganda) Tinfields, Ltd., states that working tests of the new mill were commenced in August last and it is now said to be giving satisfaction, the recovery obtained reaching 90%. During last year 186 tons of tin concentrates was recovered, this low figure being consequent upon the change over of dressing plants. No dividend is to be paid for the year, although it is stated that the company is now producing at a profit.

Australia.—Particulars of interesting developments are given in the January report of the Wiluna Gold Corporation. The most important is in connexion with a new ore-body west of the West lode, which has been intersected at three points, giving an indicated length to date of approximately 450 ft.

New Zealand.—Shareholders of the Consolidated Gold Fields of New Zealand have been informed that as most of the company's properties have now been worked out or disposed of it is desirable that the capital should be placed on a basis more representative of the remaining assets. It is accordingly proposed to write down the face value of the shares to 4s. each, thus reducing the issued capital of the company to £50,000.

New Guinea.—The report of New Guinea Goldfields, Ltd., for the year to September 30 last shows that the installation of a central power plant has been completed and with the power now available it will be possible to push forward development below water level. The plant for treating the flat ore-body has been landed and is in process of erection. The company's share from tribute working on the alluvial leases brought in £34,646 up to the end of the year.

India.—The report of the Indian Copper Corporation for the three months to

September 30 last shows an all-round reduction in costs. The ore produced and sent to the mill amounted to 11,408 tons, milling costs during the quarter being reduced by a further 4%. The production from the smelter amounted to 1,050 long tons of refined copper, overall recovery having been increased to 93·12%, while costs per long ton showed a further reduction of 5·7%. The rolling-mill output was 999 tons, an increase over the first half of the year of 26%, costs per long ton of yellow metal having been reduced by £8 per ton.

Malaya.—The report of Batu Selangor Tin Dredging for the year ended August 31 last shows the revenue from the sale of tin ore to have been $23,876 and the net profit $10,007. Of this amount $2,738 has been written off preliminary expenses and $1,312 off the development account and, after making other allowances, the sum of $5,939 was carried forward.

Panama.—The report of Panama Corporation, Ltd., for the year to May 31 last shows that operations were concentrated on points where developments had proved favourable. The treatment plant at Remance has been operating since August last and is stated to be now working at full capacity. Up to December 31 it had treated 14,178 tons of ore, the gold shipped amounting to 3,963 oz. Developments in the El Mineral district were referred to in these columns last month. At an extraordinary meeting, which is to be held following the annual meeting this month, it will be proposed that the whole of the assets and undertaking of the company should be transferred to a company to be formed under Canadian law and to exchange present holdings into new dollar securities. It is stated that the advantages of this arrangement are obvious, when it is considered that the company requires extensive further finance for its properties and that all expenditure has to be incurred in dollars.

Venezuela.—In view of delay caused by the legal transfer in Venezuela of the Bolivar Venezuela property to the New Goldfields of Venezuela it was decided to postpone the closing of the accounts of the latter company until June 30, 1931. The report now published accordingly covers a period of 17 months to that date and it shows that 64,836 tons of ore, averaging 9·0 dwt. in value, was treated by the mill, the yield being valued at £105,829. The ore reserves at the end of June were estimated to be 535,388 tons, averaging 9·9 dwt. per ton. The new mill was started in April, 1930, and during the period under review the average tonnage treated daily was 155, a figure which has now been increased to 225 tons per day, while treatment costs in the new plant average Bs. 15·68 per ton, as against Bs. 35·22 by the old. Recent operations are considered as proving that the mine is now on a self-supporting basis.

Yugoslavia.—A progress report of Trepca Mines, Ltd., covering the three months to December 31 shows that 79,864 metric tons of ore was milled, 10,704 tons of lead concentrates and 11,562 tons of zinc concentrates being recovered. The revenue for the period was £141,256 and the working profit £57,332. Good progress is said to have been made with the new power plant and mill extension, work on which was started in October.

Sweden.—The Kreuger and Toll Company announced last month that the option it held over certain important mining properties in northern Sweden had been exercised. The most important of these properties is the Boliden gold mine, discovered in 1924 by geophysical methods. The ore at this mine averages 20 grm. gold and 60 grm. silver per ton and has a copper content of 2%, while part of the ore-body is very rich in arsenic. Treatment plant for the ore has been erected at Rönnskar, on the Baltic, 30 miles from the mine, the present capacity of the plants at Boliden and Rönnskar being 300,000 tons per annum. Further extensions, which will double this capacity, are expected to be completed during the present year.

Siberia.—It was announced last month that the agreement for the retransfer of the Tetiuhe property to the government of the U.S.S.R. had been ratified, the property being transferred as from January 2 last.

Cornwall.—A circular forwarded to shareholders of Geevor Tin Mines, Ltd., last month informed them that it had been decided to re-open the mine on a limited scale, commencing in the Victory section, operations to be expanded as circumstances permit. It is anticipated that the adoption of this course will cover all expenses and prevent the gradual depletion of the company's reserves in the upkeep of the mine.

Tin.—At a meeting of the committee of control of the International Tin Pool held in London last month it was stated that the pool now holds 21,000 tons of tin metal, all of which appears in the "visible" supplies. It was also agreed that the existing minimum sale price of £150 should be increased to £165.

THE EAST GEDULD MINE

By H. R. HILL

The author, who is consulting engineer to the Union Corporation, Ltd., describes the development and equipment of this property on the Far East Rand.

GENERAL.—East Geduld Mines, Ltd., was incorporated on January 11, 1927, with an initial capital of £350,000. This amount has since been increased to £1,560,000, the shares in respect of which have been fully subscribed and issued. The property of the Company consists of the eastern portion of the farm Geduld and is 2,640·5 claims, or 3,881 English acres, in extent. It is situated in the area of the Witwatersrand goldfields known as the Far East Rand and is about 30 miles distant from Johannesburg. The mine has as its immediate neighbours three producing mines, Geduld Proprietary Mines on the west, New State Areas on the south, and Modderfontein East on the north. To the east the mine is bounded by the Grootvlei Proprietary Mines, a company which has recently acquired a lease area from the Government and which has arranged to commence development operations.

As a matter of historical interest, it may be mentioned that the farm Geduld was owned by President Kruger, and that the original dam built in 1888, from which several mines and the Victoria Falls and Transvaal Power Company draw water supplies to-day, is still known as the "President's Dam." The name Geduld means "Patience," and it is significant that, although the farm was purchased from President Kruger in 1899, the eastern half was not brought to the productive stage till 1931.

Lease Formula.—The mining rights of the East Geduld area were owned solely by the Government, which has leased them to the company and takes as payment for the claims a share in the profits of the company. The Government is entitled to a share of the profits calculated according to the formula :—

$$Y = 50 - \frac{1200}{X}$$

with a minimum for Y of 10%, where Y is the percentage of profits payable to the Government and X is the ratio of profits to recovery after deducting from the profits an allowance for amortization, which will redeem the capital expenditure over the life of the mine. The diagram in Fig. 1 illustrates the value of Y (the percentage payable to the Government) for varying values of X.

In addition the company has to pay the ordinary taxation imposed upon the profits of mining, provided, however, that if the scale of taxation is increased to exceed the scale in force in 1927, the amount payable as the Government share of profits is to be reduced by the amount of the increase.

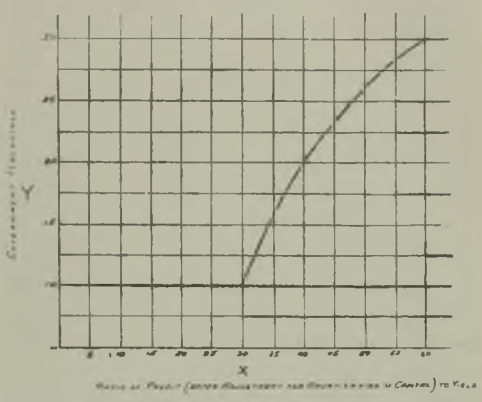


FIG. 1.—DIAGRAM SHOWING OPERATION OF THE FORMULA $Y = 50 - \frac{1200}{X}$.

GEOLOGY.—The surface geological features at the mine are of little interest, the Witwatersrand Series being covered by coal measures and dolomite. The most important points in this connexion were the thickness of the dolomite and the amount of water likely to be met at the point chosen for shaft sinking. Unfortunately for East Geduld, the thickness of the dolomite proved to be 986 ft. and the maximum quantity of water 2,200,000 gallons per day, whereas, in a neighbouring shaft, where the thickness of dolomite approximated 945 ft., the maximum quantity of water handled per 24 hours was 900,000 gallons.

The section in Fig. 2 gives the details of the geological features of the shaft.

SHAFT.—(*a*) *Shaft-sinking.*—The East Geduld shaft is rectangular in shape and consists of five compartments each 5 ft. 8 in. by 8 ft. 0 in. inside timbers. The wall plates consist of 9 in. by 9 in. timber, the dividers are also 9 in. by 9 in. with corner studdles of 8 in. by 8 in. and intermediate studdles of 10 in. by 4 in. The guide runners in the skip and cage compartments are 9½ in. by 4½ in.

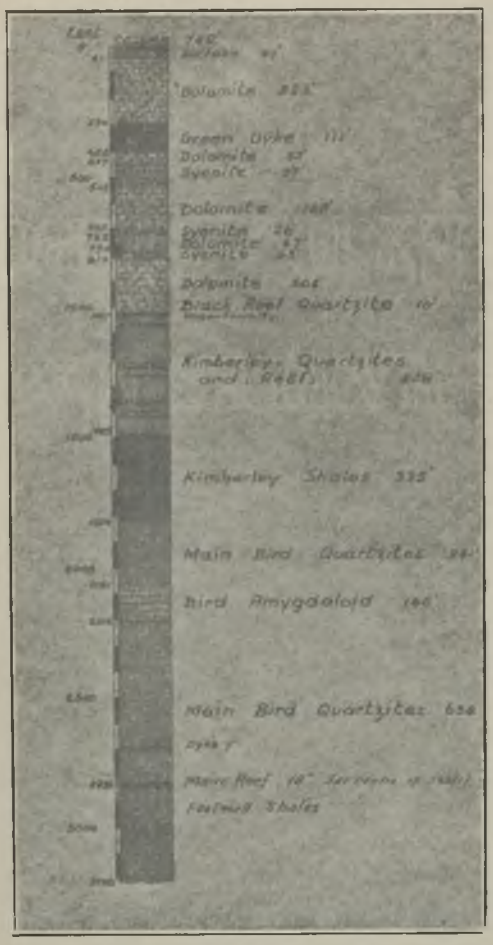


FIG. 2.—VERTICAL SECTION OF EAST GEDULD SHAFT NO. 1—DATUM 6,000 ft.

and in the pipe and cable compartments 5½ in. by 4 in. The setts are placed at 6 ft. 9 in. centres, and at every 200 ft. bearer sets of four 8 in. by 6 in. steel girders have been installed.

The details of sinking the shaft are of interest and the following extract is taken from a paper read by Mr. E. P. Cowles, the General Manager of East Geduld Mines, Ltd., before the Transvaal Association of Mine Managers :—

In the sinking of Geduld's seven shafts, the dolomite was passed through at a maximum depth of 512 ft. and only one shaft struck much water, less than 500,000 gallons per day for a short period. The dolomite was expected to be thicker at East Geduld, but, on account of the draining of these measures for many years by adjoining mines, it was not thought that there would be large quantities of water. Unfortunately the shaft has passed through the greatest thickness of dolomite so far encountered, as far as I know, and the quantity of water dealt with has, I think, been exceeded in only one instance on the Rand—at Springs No. 1 Shaft.

The sinking skips have 2½ tons capacity and the skeletons are 45 ft. long equipped with a fixed ladder from above the skip to the bridle. The following winding engines were erected for sinking :—

Geared steam hoist—No. 1 and 2 compartments.
Direct steam hoist—No. 3 and 4 compartments.
Steam winch No. 5 (pipe and cable), compartment.

It was expected that the permanent electric winders would be brought into commission during sinking and that the Cochrane direct hoist would be transferred to No. 5 compartment, but, owing to the restrictions placed by the Mines Department on sinking with electric hoists, it was decided to replace the geared hoist only and to go to the bottom, 3,200 ft., with the other two steam winders. As no ladder way is provided it is compulsory to have two conveyances in the bottom when blasting.

Prior to starting sinking, a pilot winze was sunk to solid rock at 54 ft. The first sod was cut on April 15, 1929, and at that time no power or water were available and no buildings had been started. It may be of interest to give the dates at which the various items of plant necessary for sinking were brought into commission.

The concrete mat is 48 ft. by 46 ft. and 2 ft. 6 in. thick strengthened by a ring around the collar of the shaft, making a total thickness here of 4 ft. 3 in. with concrete housing around the shaft to 6 ft. above natural ground level. Concreted into the mat are 20 in. by 6½ in. girders 40 ft. long to support the headgear and 10 in. by 6 in. girders from which the shaft timber is hung. The excavations were completed on May 7, and the mat was finished on May 28.

The permanent steel headgear, with temporary sinking bins, was erected from June 5 to September 22. Two 250 h.p. boilers were installed from May 7 to August 29. The two steam winding engines were given trial runs on September 5, and began working when the headgear was finished. The transformer house was equipped to deliver power on September 21. The 40-drill electric compressor came into commission on September 23. It took 5½ months to complete the essential plant and, in addition, three cottages, shaft offices, change house, blacksmith shop, timber shed, compound, magazine, and cooling dam had been completed.

A 5-ton steam crane was used as soon as the erection of the headgear permitted, that is after June 17. The shaft was sunk to solid dolomite 60 ft. below the collar and lined with concrete to that depth. Eighty feet were sunk, mainly with the crane, in September, using portable compressors, and 161 ft. in October with the steam hoists.

The methods of drilling, lashing, and timbering do not differ appreciably from standard practice, but a description of the history of the sinking with particular reference to the quantities of water encountered and the methods of pumping and baling adopted may be of interest.

At a depth of 290 ft. a certain amount of water was encountered and a large dyke, known locally as the "green" dyke, was struck in the shaft, continuing to a depth of 408 ft. The chief characteristic of this dyke, besides its colour, is that on exposure to air it quickly crumbles and swells and is, therefore, dangerous in a shaft and it was decided to concrete the whole section of the shaft where the dyke was exposed. A hitch 6 ft.

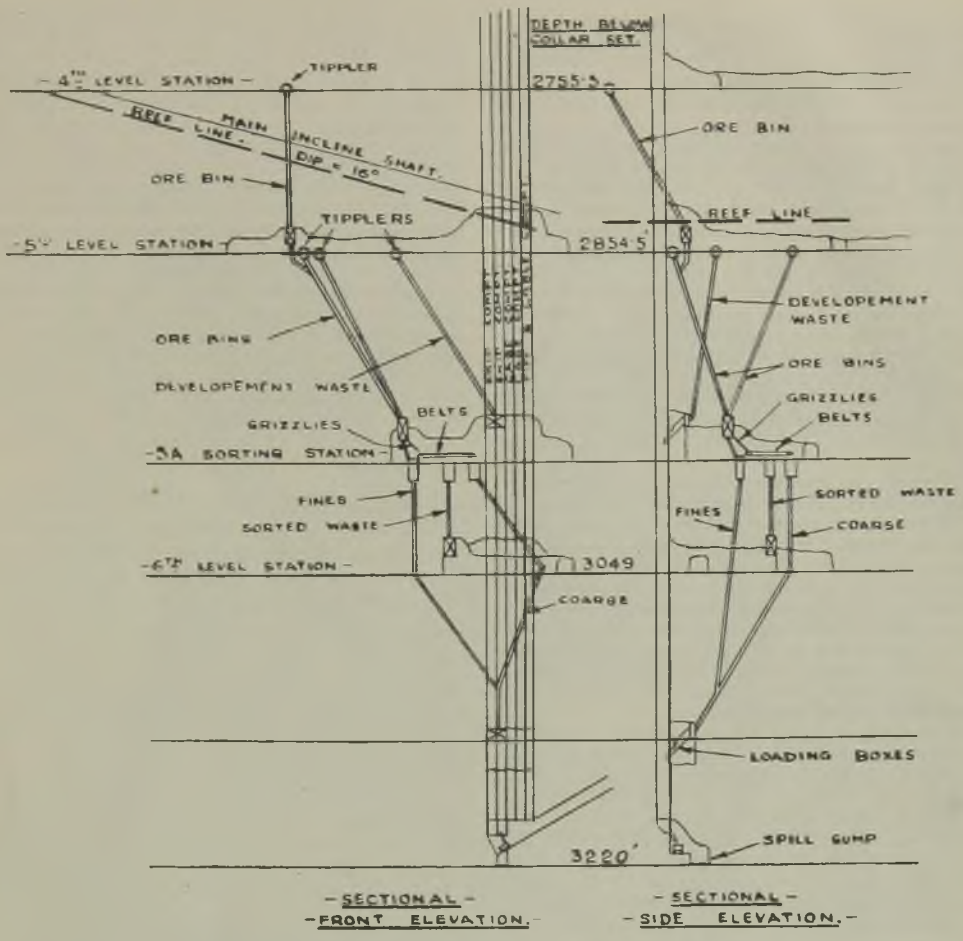


FIG. 3.—SECTION THROUGH SHAFT AT EAST GEDULD.

deep was cut in solid dolomite below the dyke, the shaft having been carried down through the dyke with larger dimensions to allow for the concrete. As a further support for the concrete, 8 in. by 6 in. girders were concreted in across the short axis of the shaft as bearers under the dividers. These were 20 ft. long and, as the shaft was to measure 10 ft. 6 in. inside the concrete, this allowed a bearing of 4 ft. 9 in. on each side of the shaft. Distance pieces of 2 in. pipe were put between the girders and through the pipes ran long 1¼ in. bolts to bind the girders together. Between the girders, and on the bottom web, 30 lb. rails were placed and this completed the foundation for the concrete to rest on. On the hitch numerous holes were drilled and old jumpers were placed in the holes before the concrete was poured.

Wire ropes 1½ in. diameter were suspended from above the dyke and fastened to the girders to reinforce the concrete. Wooden shuttering was then put in place and the space behind filled up with concrete which was mixed on the surface. The thickness of the concrete varied from 4 ft. 6 in. to a minimum of 12 in.

A small pump station and sump were cut above the dyke and equipped with air pumps. It was necessary to stop three times to line the shaft with concrete and straight sinking was not resumed until December 28. The rate of sinking after that date was equivalent to about 240 ft. per month, and the sinkers did not miss a blast for 13 days. A 2-stage Sulzer pump had been installed at the 300 ft. station from which 150,000 gallons per day were pumped. The water below that point was negligible.

A fissure of steep inclination, nearly parallel to the long axis of the shaft, was intersected on January 4 at 500 ft. The quantity of water from this fissure was 100,000 gallons per day at the start, which increased to 300,000 gallons by January 9, 500,000 gallons by the end of the month, and 900,000 gallons by the end of February. Some idea of what a million gallons a day means at the bottom of a shaft is given by stating it as a rise of 4 ft. in 15 minutes.

During two weeks, following January 9, the shaft was sunk 33 ft. to 570 ft., where a large ring, pump station, and sump were excavated in a similar period. The last three weeks of February gained only 28 ft. The slow rate of progress was due to flooding the bottom frequently with continuous increases of water; using the skips for baling, installing pumps

and delivery columns; and the short rounds obtained with the timber close to the bottom and as a result of the number of misfires. The skips baled from the shaft bottom for 7 weeks averaged 670 per day and reached a peak of 1,200, on which day a round was also blasted.

It was necessary, when the water was first struck, to give up one of the hoists for raising and lowering a sinking pump. Later on, the timber was kept within 16 ft. of the bottom, the blocking and dividers of the last three or four setts being left out, and sinking pumps were slung from the wall plates. Finally a system of placing four No. 7 horizontal Cameron pumps on the bottom wall plates was adopted. It was not necessary to disconnect suctions, which were pulled up and slung over the timber before blasting. One effort was made with the largest sinking pump available, a No. 12 weighing some 3½ tons. It was pumping against 300 ft. head and nearly every time it sucked air a flange was blown out. The experiment did not last long.

At the end of February, there were four electric pumps at 300 ft., five air-pumps and a diamond drill at 570 ft., and three air pumps a few feet lower down the shaft. The diamond drill-hole was put down to locate the quartzites in order to obtain information for spacing temporary pump stations.

Two electric pumps were installed in the 570 ft. station early in March, risking the flooding of the shaft which was only 30 ft. deeper. The diamond drill reached the quartzites in April at 1,030 ft. below the collar, after which two more electric pumps were placed in this station.

No increase of water in the bottom occurred and the shaft was sunk 100 ft. in March, 95 ft. in April, and 166 ft. in May, with never less than four air pumps at the bottom sett. A ring was put in at 700 ft., equipped with air pumps, and a pump station was cut at 800 ft. On May 27 the shaft had been sunk 143 ft. in three weeks, the quartzites were only seventy feet away, and all the shaft's troubles seemed over. The first electric pump had been put in the 800 ft. station on the previous day, and the total water handled was about 900,000 gallons per day.

A water fissure was drilled into on the morning shift of May 28 at 960 ft., the same depth at which the diamond drill intersected water under high pressure. The quantity of water was not great; the round was blasted in the ordinary way, and it was not until the afternoon, when a set was being hung, that the flood occurred—an extra 600,000 gallons per day. The baling increased to 2,319 skips on May 29, and the water rose up to the fifth sett from the bottom with four pumps working under water. The platform hoist was used to place a second electric pump at 800, but the skips could not be stopped to instal more air pumps in the bottom. The baling averaged 2,100 skips per day for ten days, and a few skips of rock were cleaned out of the bottom on two days during that time. The record baling was 1,358 skips in a day with one hoist. There were 7 air pumps in the bottom, eventually.

A ring at 900 ft. was timbered and equipped with air pumps and by June 8 additional electric pumps had been put in at 300, 570, and 800 ft. The top two stations were already crowded, and placing extra pumps in a short time with everything running full out was not easy. The water reached a peak of just over 2,000,000 gallons per day, of which more than half was below the bottom ring.

By June 10 the position was sufficiently well in hand to risk hanging up one steam hoist to change over to the permanent electric winder with 800-gallon baling tanks. The first blast was obtained on June 12 and the quartzites intersected 67 ft. lower down on July 11 at 1,027 ft. below the collar. A ring and air pumps were put in at 1,000 ft. and on July 20 at 1,065 ft. the permanent dolomite station and sumps were started. During this period much difficulty was experienced through blasting timber and pumps, the Black Reef quartzites doing far more damage than the dolomite. It was necessary to hang as many as four dummy wall plates with hanging bolts and studdles on each side of the shaft below the bottom sett. The station was completed on September 2, 9,000 tons having been excavated, and in addition the shaft was sunk 46 ft. and a brow bin was put in. Sinking was resumed on September 3 and good progress was then obtained, the shaft making about one and a half million gallons per day, handled by 16 temporary electric pumps in four stations.

Shaft sinking was completed in May, the total depth being 3,214 ft. During June work was concentrated on the bin fronts and the shaft put into commission on July 6, 1931. The permanent equipment in the shaft consists of two three-deck cages and two rock skips. The cages each have a capacity of 81 men, or 13,500 lb., and the weight per cage is 11,945 lb. The rock skips each have a capacity of 7½ tons of ore, the weight of the skip being 10,070 lb.

The headgear, which is also of five compartments, is constructed of steel, of imported British sections, designed and fabricated locally. The height from foundation level to centre of sheaves is 105 ft. The clearance in the headgear for the rock skips is 10 ft. and for the cages 64 ft. Landing platforms are provided at the bank for egress from the three-deck cages. These can be wheeled aside when lengthy material such as rails, pipes, timber, etc., are being sent underground.

The four sheaves for skips and cages are 14 ft. in diameter, grooved for 1¼ in. diameter ropes and are of built-up design, with double-channel arms, wrought-iron rolled rims, cast-steel centres, and double-faggotted iron spindles 11 in. in diameter. The breaking stress of the steel is 134 tons per sq. in. and the breaking strain of the rope 154/155 tons. The average weight of the rope is 5·419 lb. per foot.

(*b*) *Station Layout.*—The shaft is connected with the mine workings on the 4th, 5th, and 6th Levels and a diagrammatic section is given in Fig. 3. The 5th Level has been laid out to deal with the handling of ore, while the pumping of the underground water will be dealt with at the 6th Level Station.

The ore from the various up and down

haulages, which do not feed direct into the Main Station at the 5th Level, will be collected on two transfer haulages of a total length of 10,850 ft. driven on straight lines and of a uniform grade of 1% face to the station. The plan of the 5th Level Station is shown in Fig. 4. The elevations of the tracks are not shown on this plan, but it may be sufficient to state that the full trucks are elevated by the haulages to a height sufficient to enable them to gravitate through the tipplers to the hook-on points of the various haulages.

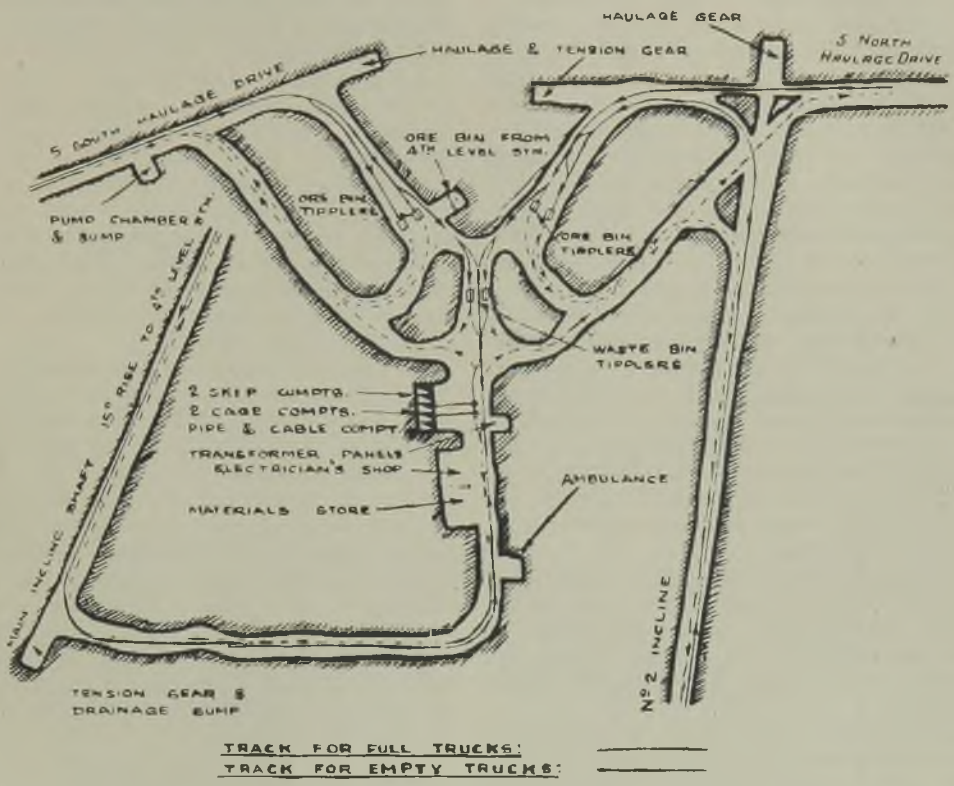


FIG. 4.—PLAN OF THE 5TH LEVEL STATION, EAST GEDULD.

The ore from the two sets of tipplers serving the North and South haulages joins at the 5A Station and will pass over a 4 in. grizzley, the undersize passing through the grizzley continuing on, down one limb of the ore pass to the station in the vertical shaft. The oversize, or plus 4 in., rock will pass from the grizzley onto two 36 in. sorting belts, being well washed in the inclined portion of its travel. The sorted ore will drop into another limb of the ore pass, joining up with the fines just before the bin front of the station in the vertical shaft is reached. The waste sorted out will be dropped into a bin under the sorting belt and drawn off through boxholes at the 6th Level. From this point the waste can be distributed to any working place in the mine for use as a packing material for the support of the hanging-wall.

The station will be lit by mercury vapour lamps and it is anticipated that no difficulty will be met with in sorting out the larger pieces of waste rock. There is no doubt that the hoisting capacity of the shaft will be increased by an amount corresponding to the tonnage of waste sorted and, as there will be no sand from the reduction plant available for sandfilling, the ability to make use underground of all the larger pieces of waste rock broken may obviate the necessity of quarrying waste underground as is often necessary.

(*c*) *Sorting Station.*—Provision has been made in the arrangement for handling ore for an underground sorting station, known as 5A Station, and the erection of the necessary equipment is now being proceeded with.

(*d*) *Pump Stations.*—As stated previously the main pumping station is situated at the

6th Level and it is intended to make the drives at this horizon follow the reef contour to the north and south boundaries.

The water is pumped from the mine in two stages, the 6th Level or lower station being 3,045 ft. below the surface and the upper, or dolomite, station 1,065 ft. The lower station equipment consists of four Allen & Sons high-lift centrifugal pumps, each with high pressure section of seven stages and low pressure section of six stages, mounted on one bedplate, with motor in between, connected to each section by flexible couplings. The capacity of each pump is 40,000 gallons per hour, against a total head of 2,050 ft., including friction, with a motor of 700 b.h.p., 1,500 r.p.m., squirrel-cage type. There are two 10 in. diameter pipe columns from the lower to the upper station. The total sump capacity at the lower station is about 500,000 gallons and is capable of extension should circumstances require. Settling sumps are also provided.

The upper station equipment consists of four Allen & Sons high-lift centrifugal pumps, each having a high pressure and low pressure sections of five stages each, mounted on one bedplate, with motor between, connected to each section by flexible couplings. The capacity per pump is also 40,000 gallons per hour, against a total head of 1,550 ft., the motors being each 550 h.p., 1,500 r.p.m., squirrel-cage type.

The upper station also has to deal with the dolomite water as well as the water in the mine, the dolomite water amounting in October, 1931, to 24,000,000 gallons per month out of a total of 51,000,000 gallons pumped.

It should be noted that it was originally intended to have two stages of about 1,500 ft. each, with pumps identical at each station, but owing to the dolomite measures in the shaft carrying water down to below 1,000 ft., it was decided, in order to avoid the expenses of a special station for dolomite water only, to instal the upper station at 1,065 ft. with sumps arranged so that dolomite water, piped down from rings in the shaft, could if necessary be kept separate from the mine water delivered from the lower station. As the pumps for 1,500 ft. head had already been ordered, and were installed at 1,065 ft., the difference in head was adjusted by the introduction of dummy stages in the pumps. At this station the dolomite water sump has a capacity of 100,000 gallons and the mine water sump 120,000 gallons approximately.

Pumping from the various working places in the mine to the lower main station is done by means of electrically-driven centrifugal pumps, and in some cases by air pumps, capacities and location varying according to requirements. The water pumped from the mine is delivered into the headgear tank through three 10 in. diameter pipe columns and pumped thence to surface reservoirs, one of which is equipped with sprays for cooling the compressor circulating water, while the other is furnished with a pumping station for supplying the make-up water for the reduction works.

Underground Development Work.—Development work was started from the Geduld Proprietary Mines headings immediately after registration of the Company on January 11, 1927, and up to June 30, 1931, 63,054 ft. had been accomplished. Of this footage 43,495 ft. were on reef. The result of this work has been to develop an ore reserve of nearly 4,000,000 tons of an estimated value of 7 dwt. over a stoping width of 58 in.

In July, 1929, work was commenced on the underground station layouts, and on the ore bins to serve the vertical shaft, and considerable progress was made with this work before the work of sinking the shaft was commenced in earnest, the cross-cut on the main station to connect with the shaft being completed while the concrete shaft lining from surface to solid rock was being put in. All drilling in development ends and station work was done on day shift, as blasting operations were permitted only once in the 24 hours and had to be carried out so as not to interfere with mining operations on the Geduld Proprietary.

While the maximum footage obtained in any one end during the month was 201 ft., the general progress must be considered excellent when it is borne in mind that all station waste and development rock in the latter stages had to be trammed a distance of approximately 17,000 ft. to the nearest shaft, and that the time taken by the workmen in travelling this distance to reach the working face reduced the working time very considerably. It was possible, however, to complete the development programme several months before the shaft was available, and work in this connexion was practically suspended during the second quarter of 1931 until the commencement of hoisting operations through the East Geduld shaft enabled development work to be resumed.

The track gauge used by Geduld Proprietary Mines was 18 in., while the gauge decided on for East Geduld was 24 in. and, while it was possible to change over most of the track, the fact that the development work was ahead of time enabled the balance to be completed with much less difficulty.

Haulage Systems.—It is proposed to use the endless-rope haulage system for the handling of ore and material in the main haulage ways of the mine. The 5th Level has been chosen as the main transfer Level and will be driven on a straight line South for a distance of 4,250 ft. and North for 6,600 ft. from No. 1 Shaft. All the ore above the 5th Level will be brought down on three inclined endless-rope haulages, the original Main Incline haulage feeding through an ore pass into the main ore bin.

The ore below the 5th Level will be brought up on four inclined haulages to the 5th Level horizon and brought along the transfer level to the main ore bin which is on the 5th Level. The plan in Fig. 5 shows the proposed scheme of haulages.

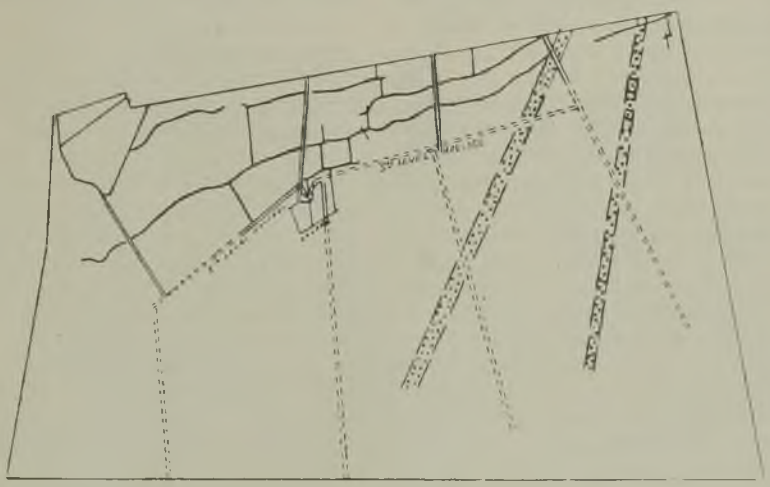


FIG. 5.—PLAN OF EAST GEDULD MINE, EXISTING HAULAGES BEING SHOWN THUS ═══ AND PROPOSED HAULAGES = = = = :.

TREATMENT OF ORE.—The general layout of the plant is shown in the accompanying Fig. 6.

Headgear Ore Bins.—The ore is delivered by the skips into bins forming part of the headgear. These were designed and built locally of imported British sections and plates. The bins are divided into three compartments, namely :—

Coarse Ore Bin of 710 tons capacity.
Fines Ore Bin of 600 tons capacity.
Waste Rock Bin of 277 tons capacity.

The ore is tipped from the skips onto grizzley bars spaced $\frac{3}{4}$ in. apart, the oversize product passing to the coarse bin and the undersize to the fines bin. Hinged chutes are provided for tipping waste rock direct into the waste bin, whence it is transported, in trucks, to the waste rock dump by an endless rope haulage.

Ore Crushing, Washing, Screening, and Sorting Plant.—The ore from the coarse bin in the headgear is fed by means of two Ross Chain-Feeders into two Hadfield's Primary double-toggle jaw-crushers, with inlet openings 30 in. by 23 in., the jaws being set to 7 in. opening and having an hourly capacity per crusher of 75 tons.

The ore from the fines bin in the headgear is delivered direct to a 24 in. cross conveyor belt, discharging onto a 24 in. transfer conveyor belt, which delivers on to the main supply belt to the tube-milling plant.

Crushed rock from the primary crushers is elevated by means of two 36 in. inclined conveyors to a screening and washing plant where the ore is divided into three products : (*a*) Minus 7 in. + 4 in., (*b*) minus 4 in. + $1\frac{1}{2}$ in., and (*c*) minus $1\frac{1}{2}$ in. The ore on entering the washing tower is thoroughly washed, the washings gravitating partly to a Dorr classifier direct and partly to the suction sump of two 4 in. Wilfley sand-pumps, whence they are elevated to a Dorr classifier.

The coarse or raked product from the classifier is delivered direct on the before-mentioned 24 in. transfer conveyor belt, while the fine overflow gravitates to a 26 ft. diameter by 10 ft. deep Dorr collector tank.

The overflow from the collector tank gravitates to the suction sump of two twin-stage Sulzer pressure-pumps for supplying the washing sprays, while the underflow is pumped direct to the tube-milling plant. The ore in its three sizes is fed on to three sorting belts, which are all 36 in. wide and pass over the waste rock bin, into which the sorted out waste is dropped by the sorting boys and transported thence in trucks by rope haulage to the waste rock dump. The ore on the belt conveying the + 4 in. – 7 in. product passes to a pebble bin and, in the event of the pebble bin being full, is diverted by means of a chute into the secondary crusher bin. Similar arrangements have been made in connexion with the + 1½ in. – 4 in. product. The pebbles are delivered to the tube-mills by means of an endless-rope haulage system.

Secondary Crushers.—The pay rock from the plus and minus 1½ in. sorting belts is delivered direct to the three Newhouse high-speed gearless rotary crushers, each crusher having a capacity of about 80 tons per hour of 75% minus ¾ in. product. The crushed product from these crushers drops direct on to a 36 in. main incline tandem-driven conveyor belt and, together with the fines from headgear grizzleys and raked product from Dorr classifier, is elevated and delivered on to a 36 in. shuttle belt operating on top of the primary tube-mill ore bins and distributing it as required. Dust from the secondary crushers is removed by means of a suction fan.

Tube-Milling Plant.—The ore from the primary tube-mill ore bins is conveyed by means of three short 24 in. conveyor belts and fed together with pebbles into feed hoppers at the inlet ends of the primary tube-mills. These are three in number and are each 8 ft. 0 in. diameter by 16 ft. 0 in. long internally. The drive for each consists of a 250 h.p. 750 r.p.m. motor direct-connected to a totally-enclosed 6 to 1 ratio single reduction gear, the outgoing shaft of which is coupled to a countershaft carrying a pinion which engages with the spur ring round the barrel of the tube-mill, ratio 5·2 to 1 ; total speed reduction 31 to 1, tube-mill speed 24 r.p.m.

The outflow from the primary tubes gravitates to the suction sump of two Wilfley sand-pumps (each driven by a 60 h.p. motor), which elevate the pump to an automatic overhead distributor, which feeds a series of launders delivering to ten Dorr classifiers. Each of these Dorr classifiers has a raking compartment 8 ft. 0 in. wide by 18 ft. 0 in. long.

The coarse or raked product from these classifiers is fed, together with pebbles, into feed hoppers at the inlet ends of the secondary tube-mills. These are ten in number, each one being 6 ft. 6 in. diameter by 20 ft. 0 in. long. They are driven by geared motors, motor and gear being built in one casing with the high-speed pinion of gear keyed on motor shaft. Each motor is 250 h.p. and runs at 1,500 r.p.m., the gear ratio is 12 to 1 ; out-going shaft running at 125 r.p.m. and coupled to countershaft carrying pinion engaging with the spur ring round the barrel of the tube-mill, ratio 4·82 to 1, giving an approximate tube-mill speed of 25·9 r.p.m.

The outflow from the secondary tubes is returned by means of air lifts to the ten superimposed Dorr classifiers, thus forming closed circuit. The overflow from the classifiers gravitates to the suction sump of three 8 in. Wilfley medium sand pumps, each driven by a 60 h.p. motor, and is elevated by these pumps to four Dorr bowl classifiers with 18 ft. 0 in. diameter bowls and raking compartments 8 ft. 0 in. wide by 31 ft. 8 in. long.

The coarse or raked product from the bowl classifiers is delivered to four tertiary tube-mills. These mills are identically the same in size and method of driving as the three primary mills, except that the ratio of open gear on the tube-mill is 6·67 to 1, giving a tube mill speed of 18·75 r.p.m. The outflow from the tertiary tubes gravitates to the medium sand pumps, described above.

The overflow from the bowl classifiers is gravitated to the suction sump of three 8 in. Wilfley fine sand-pumps each driven by a 75 h.p. motor, and is elevated by them to the slime treatment plant. At each end of the tube-milling plant a spillage sump is provided, each sump being equipped with two 4 in. Wilfley spillage pumps, driven by 10 h.p. motors. This arrangement handles all spillage floor washings and contents of classifiers at week ends, and returns same to coarse sand sump for reintroduction into circuit when starting up after Sunday stoppages.

Tube-mill liners throughout are of second-hand 80 lb. per yard railway rails ; and liners, trunion liners, scoop discharges, etc., are of hard white cast-iron. All launders for coarse sand pulp have a fall of 10% and those for fine sand not less than 4%, and all are lined with hard white cast-iron plates.

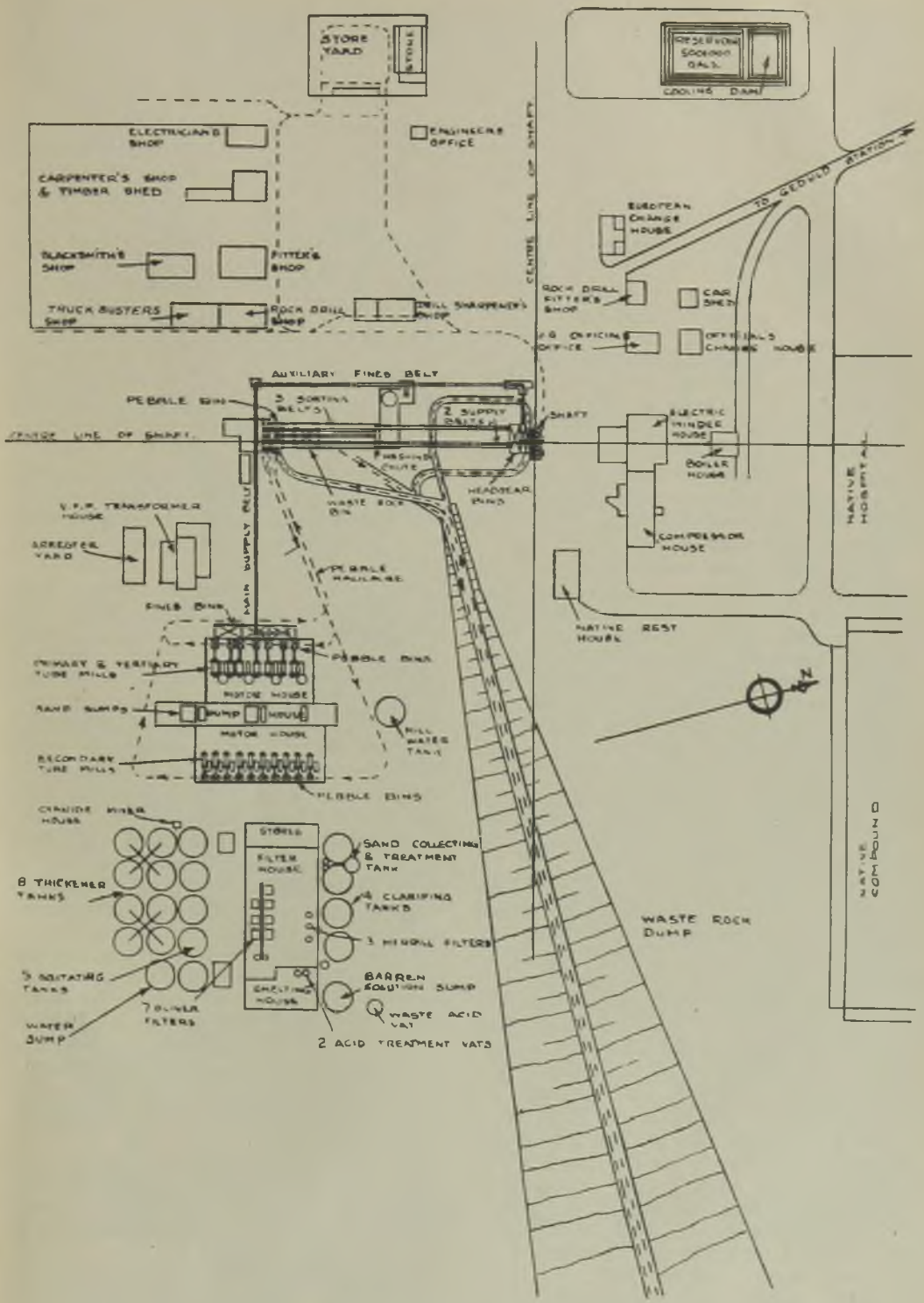


FIG. 6.—LAYOUT OF THE PLANT AT EAST GEDULD MINE.

Slime Treatment Plant.—This plant consists of eight 50 ft. 0 in. diameter by 18 ft. 0 in. deep Dorr double-compartment, or single-tray, thickening tanks, five 50 ft. 0 in. diameter by 18 ft. 0 in. deep Dorr agitator tanks, four 50 ft. 0 in. by 8 ft. 0 in. deep clarifier tanks, Oliver continuous filter plant, Crowe vacuum de-aeration plant, Merrill zinc precipitation plant, etc.

Pulp from the tube-mill is delivered by piping to the thickener tanks, entering a division box at each tank, which feeds both the upper and lower compartments. Water is drawn off by peripheral rim launders and flows to two 15 in. Pulsometer return-water pumps, each driven by 150 h.p. motor, and is elevated to the main high level service water tank, 50 ft. 0 in. diameter by 8 ft. 0 in. deep, which supplies the reduction plant. The thickened pulp is raised by means of Dorrco pumps to a launder leading to the five agitator tanks, which are stepped down, one below the other, sufficiently to allow of a continuous flow from tank to tank.

At the inlet of the supply launder to the agitator tanks a mixer for cyanide, lime, and lead nitrate is placed, the mixture being fed into the pulp stream by means of a slow moving conveyor belt in the required quantities. The agitated and aerated solution bearing pulp is gravitated from the last agitator tank to the Oliver filter plant, which is designed to handle 2,400 tons of dry solids per 24 hours, and to deal with slimes having a screen grading of about 90 per cent. minus 200 mesh, with pump specific gravity of 1·40. The Oliver plant consists of seven filter units, each 14 ft. 0 in. diameter by 16 ft. 0 in. face, complete with all auxiliary machinery, such as driving gear, filtrate pumps, vacuum pumps, receivers, traps, etc.

The residue cake of slime ploughed off from the Oliver filter units falls on to a 36 in. conveyor belt which discharges into a puddler, whence it is transferred by means of two 6 in. Wilfley pumps to the slime residue dams. All material handled on this belt is automatically weighed and recorded by a Merrick patent conveyor weightometer.

The gold-bearing solution from the Oliver filters is pumped to the clarifier plant, which consists of four 50 ft. by 8 ft. tanks fitted with cocoa and jute filter mats, and one 30 ft. by 8 ft. overhead tank. The clarifier tanks are equipped with Butters distributors for receiving sand pumped from the bowl classifier, which, after treatment, is discharged through the bottom to trucks for feeding into the four clarifier tanks. The clarified solution then passes through the Crowe vacuum de-aeration plant to the Merrill zinc precipitation plant, which consists of three 10 ft. 10 in. diameter by 11 ft. deep by 2 ft. 0 in. cone bottom precipitation tanks, each fitted with thirty-two 4 ft. 0 in. by 6 ft. 0 in. revolving filter leaves, and at intervals of a fortnight the precipitated gold, together with the excess of zinc, is pumped to two acid treatment lead lined vats 15 ft. in diameter and 10 ft. deep.

The gold slime after treatment with acid is pumped through Johnson filter presses each containing thirty 30 in. by 30 in. leaves. The resultant cake is dried in the calcining furnaces, of which there are two, 14 ft. in length, and then smelted in a reverberatory furnace of 28 pot capacity, of which two have also been erected.

The flow-sheet of the treatment of the ore is given in Fig. 7, the details of the extraction of the gold from the gold-bearing solution being given in somewhat greater detail in Fig. 7A.

Electrical Equipment.—The East Geduld is an "All-Electric Mine," all machinery and plant, almost without exception, being electrically operated. Power is purchased from the Victoria Falls and Transvaal Power Co., to whose transformer station on the property current is delivered from the Witbank Power Station at 40,000 volts pressure, and supplied to the East Geduld's busbars at 2,000 volts. Adjoining the V.F.P. transformer station is the company's distribution chamber, with main switches controlling the various circuits to the different portions of the plant, such as winding engines, compressors, underground pumping, etc., and the reduction works.

Three sub-stations are provided for the reduction plant, conveniently situated, one each for the crushing and sorting plant, the tube-milling plant and the slime treatment plant. In addition to the 2,000 volt distribution from these sub-stations, transformers are installed therein for 500 volt power requirements and 220 volts for lighting the buildings and plant.

Generally, all motors of 50 h.p. and over are 2,000 volt, and all under are 500 volt. Current throughout, except for underground locomotives, is A.C. 3-phase periodicity of about 51 cycles per second.

Hoisting Plant.—The hoisting plant consists of two Metropolitan-Vickers electric hoists of the Ward Leonard system, with

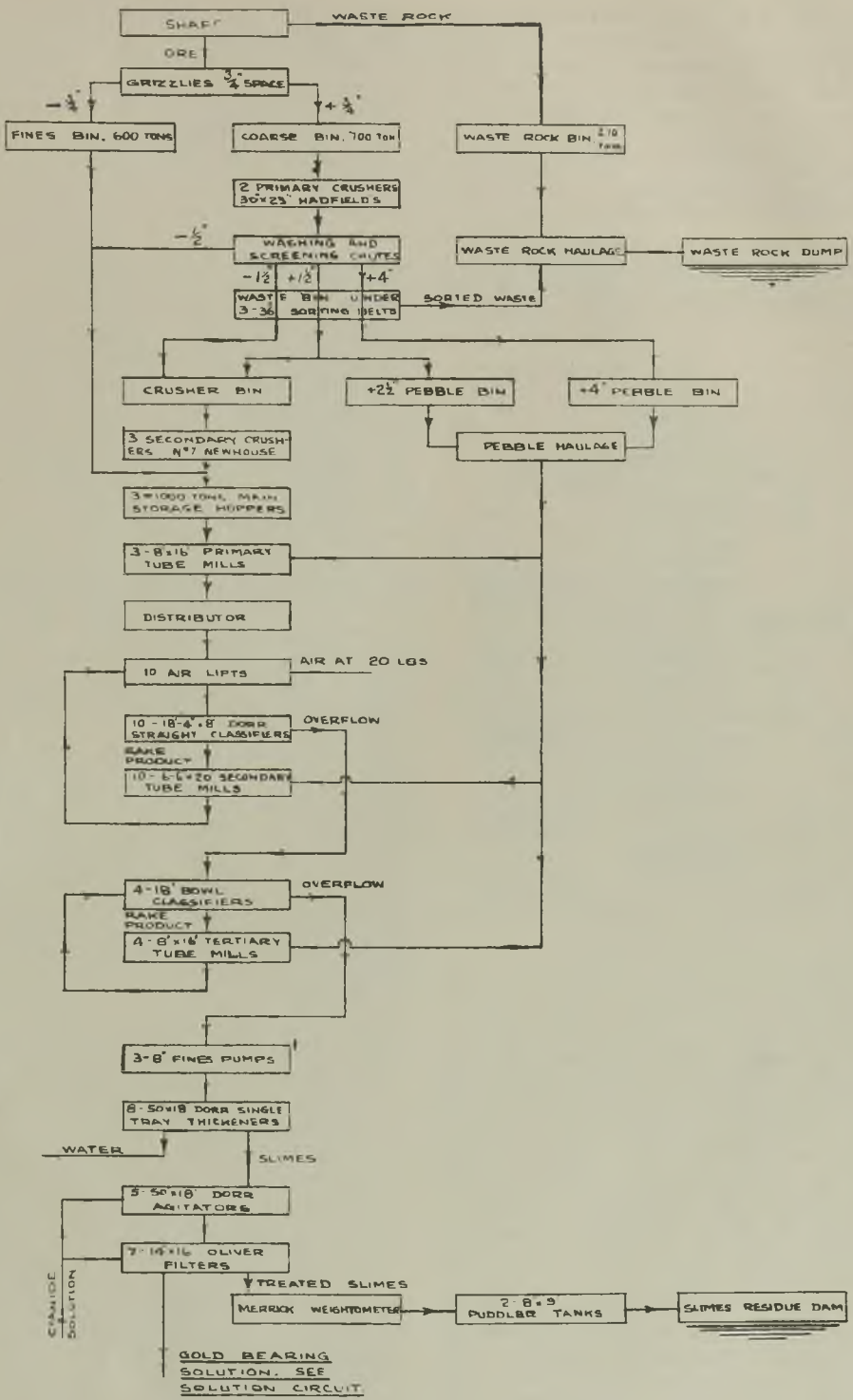


FIG. 7.—FLOW-SHEET OF THE REDUCTION PLANT, EAST GEDULD MINE, CAPACITY 60,000 TONS PER MONTH.

drums 14 ft. 0 in. wide, grooved for 1¾ in. diameter ropes, one hoist being used for rock and the other for men and materials. Both hoists are identically the same, and are designed for the following conditions :—

Total load, including weight of skip and ropes	42,500 lb.
Depth of wind, approximately .	3,300 ft.
Number of trips per hour, maximum	30

Power is supplied to the motors of the converter sets at 2,000 volts, each motor having a rated capacity of 1,800 R.M.S. h.p.

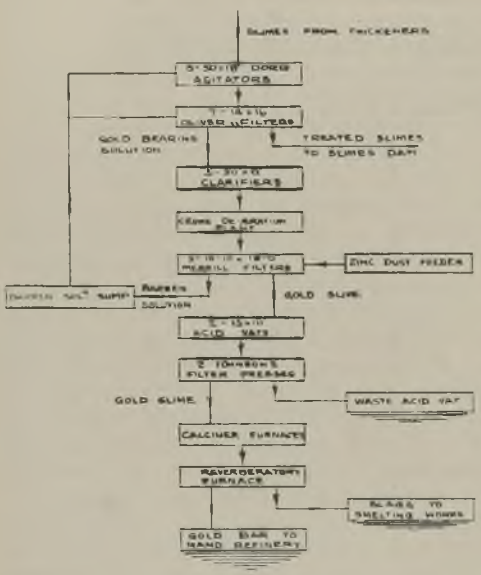


Fig. 7*a*.—Flow-Sheet of Extraction Plant, East Geduld.

with momentary peaks of 4,200 b.h.p. at a full load speed of 490 r.p.m. Direct coupled to each motor is a direct-current shunt-wound generator with normal rating of 1,750 k.w. and 3,200 k.w. peak. The direct-current winder motors each have a R.M.S. rating of 2,120 h.p., with maximum torque equivalent to 4,240 h.p. and 58 r.p.m. The two hoists are contained in a steel framed building, with 25-ton overhead travelling crane, and in an adjoining lean-to portion are the converter sets with 12½ ton travelling crane.

In another, adjoining, building, is installed a steam hoist, which operates a platform in the pipe and cable compartment of the shaft, and is used as required for shaft inspection and repairs to pipes and cables, etc. The boiler plant for this engine also supplies steam to the change houses and the compound kitchen.

Compressor Plant.—The compressed air plant consists entirely of Belliss and Morcom vertical reciprocating electrically-driven compressors of the following units :—

Three, each of 8,000 cu. ft. capacity, 1,370 h.p. motor.

Two, each of 4,000 cu. ft. capacity, 685 h.p. motor.

The above units are for 80/90 lb. pressure per sq. in. One unit of 3,000 cu. ft. capacity at 20 lb. pressure is provided for tube-mill air lifts and slime agitators.

Cooling water service consists of two 7 in. Pulsometer pumps with 30 h.p. motors (one spare), drawing water from a surface dam, and returning same through cooling sprays. Intake air to the compressors is cleaned by Visco filters. The compressed air is delivered down the shaft through two 12 in. mains. The compressor plant is contained in a steel framed house with a 10-ton travelling crane.

Workshops.—These consist of the usual run of shops, machine and fitting shop with 5-ton overhead travelling crane, carpenters', electricians', and blacksmiths' shops, and boilermakers' and truck repairing sheds. There is also a drill sharpening and tempering shop, equipped with Waugh sharpeners and oil furnaces.

Administrative and Domestic Buildings.—The mine general office building contains offices for the manager, secretary, and their staffs; also survey drawing office, samplers' office, timekeepers' office, etc. An office building for underground officials is provided conveniently near the shaft, where also are change houses for officials and men and natives, all equipped with hot and cold water and small kitchen for provision of coffee. Mine store building with storekeeper's and clerks' offices, store yards, timber sheds, etc.

Explosives are stored in a magazine, built according to Government regulations, and situated a prescribed distance away from other buildings.

Separate houses are provided for the Manager and the various officials and semi-detached cottages for the married workmen, 44 cottages being available on the mine and 24 in the Geduld Extension Township, which adjoins East Geduld Mines, Ltd. Six blocks of quarters for single men have been provided for single men and a boarding house has also been built.

Native Compound.—The compound consists of 55 rooms, forming sides of a large open

quadrangle. Each room houses 60 natives; reinforced concrete bunks, arranged in sets of four bunks per set, are provided for sleeping accommodation. On one side of the quadrangle is the Administration Block, containing offices, stores, kitchen with steam cooking plant, washhouse, etc. Sufficient latrines are situated in various parts of the quadrangle.

Hospital.—A well-equipped hospital for natives has been erected in close proximity to the compound and is under the control of a resident medical officer.

An analysis of the expenditure on surface equipment under various headings is given :—

White Labour	£14,000
Native Labour	5,500
Contracts for Erection	319,563
Contracts for Materials	258,500
Mine Stores Issued	36,366
Sundries	33,157
Total	£667,086

The orders placed overseas have been segregated into the countries of origin as a matter of interest.

	Surface. £	*Underground.* £	*Total.* £
England	144,400	15,770	173,170
America	38,140	24,800	62,940
Germany	1,700	21,670	23,370
Holland	12,500	7,100	19,600
Sweden	14,530	—	14,530
Switzerland	300	2,140	2,440
Total			£296,050

The expenditure incurred on American machinery on the surface was mostly in connexion with the cyanide and crushing plant, the underground items being chiefly shaft timber and rock-drill and drill sharpening equipment.

The main item placed with Germany was underground trucks together with a small amount of piping.

The expenditure credited to Holland and Sweden was all on account of motors and electrical equipment, while the Swiss expenditure was on pumps for shaft sinking purposes.

The capital expenditure on plant and equipment, etc., as at October 31, 1931, necessary to bring the mine to the producing stage is as follows :—

Shaft Sinking. Including Main Stations, Pump Stations, and Sumps		£268,364
Machinery and Plant to Equip Shaft. Including Headgear, Hoisting Plant, and Compressor plants	£159,113	
Reduction Plant	343,783	
Machinery and Plant :— General Purposes. Including Workshops, Transformer House and Electrical Distribution, Water Service, Magazine, and general Surface expenditure	56,664	
Buildings. Including Offices, Store buildings and yards, all housing for white employees, Change houses, Native Compound and all accessory buildings, Native Hospital, etc.	107,526	667,086
Development and Underground Equipment		425,552
Mine General Charges		11,966
		£1,372,968

Applied Geophysics.—A series of four lectures on the application of geo-electrical methods to mining and geological problems is to be given next month by Mr. A. Broughton Edge in the Department of Geology at the Royal School of Mines, South Kensington. The dates are February 17, 19, 24, and 26, at 12 noon, and the lectures are open to members of the Institution of Mining and Metallurgy without fee.

Institute of Metals.—The twenty-fourth annual general meeting of the Institute of Metals will be held on March 9 and 10, in the hall of the Institution of Mechanical Engineers, Storey's Gate. A series of interesting papers has been presented for discussion, but this year a slight innovation will be introduced, for, while the ordinary business will occupy the first day and the following morning, the second afternoon's session will be devoted to a discussion on "The Testing of Castings," which has been arranged to interest all sections of the Institute's members—those engaged in practical foundry work, engineering users of castings, and testing and investigation experts. The proceedings will be opened with a short paper by Dr. W. Rosenhain, a past president of the Institute, and visitors are invited to take part in the discussion. Ordinary business will include the presentation of fourteen papers on special subjects.

THE GOLDFIELDS OF DUTCH WEST BORNEO

By E. J. VALLENTINE, M.I.M.M.

The author gives an outline of the history of a goldfield of which comparatively little is known and treats of the origin of the deposits

HISTORY OF THE FIELD.—The extensive diluvial and alluvial gold-bearing deposits of West Borneo have been known and worked for some hundreds of years. The principal fields lie between the Sambas River on the north and the Landak River to the south, forming large plains and flats, which spread westwards from the foothills to the coast. This area comprises the four districts of Sambas, Montrado, Mempawah, and Landak, which, during the nineteenth century, came to be known as the "Chinese Districts."

Very early references to this part of West Borneo are to be found in Chinese writings. In the year A.D. 977, the dominant prince of that territory despatched an ambassador on a ceremonial visit to the Emperor of China, who was then regarded as the supreme potentate of the known world. Again, in 1406, it is recorded that the Prince of Mempawah sent an embassy to the Emperor to present an elaborate coat of woven gold wire, which is possibly the same specimen which is now preserved in the Peking Museum.

News of the richness of the goldfields gradually spread to China and parties of adventurers set out in junks to make their fortunes in this far-away country. They made their way up-river to the fields and were allowed to work by favour of the Malay rulers, to whom they had to pay royalties in gold dust. For a long time the Malays endeavoured to restrict the influx of Chinese miners, in case they should become too numerous to keep under control. However, greed for more revenues eventually overcame their fears and, about 1760, the Prince of Mempawah threw his territory open to the miners, his example being followed by the neighbouring chiefs.[1]

The scattered mining camps were generally at variance with each other, fighting over claims to land and water rights. In their own best interests and for mutual protection they gradually drew together, making their own rough laws and, at the chief mining centres of Sambas, Montrado, and Mandor, three small republics were formed, which were more or less connected with each other. They still paid tribute to the Malay chiefs, but were governed entirely by their own headmen. However, they soon became rich and aggressive and, after some fighting, they made themselves independent of the Malay overlords. They then spread further afield, wherever gold worth working was to be found, oppressing and driving away the indigenous Malays and Dyaks.

A long period of prosperity ensued, during which time the fields reached their highest level of production, Mr. J. H. Tobias giving the gold exported for 1823 a value of 80 million guilders (£6,666,700).[1] It is stated that the official outputs were less than the actual production, owing to some of the gold being taken out of the country by irregular channels. It would seem to be reasonably safe to assume, therefore, that the fields were then producing about a million ounces of gold dust per annum. About 1850, the Chinese population engaged in mining on these fields was estimated to be 34,000 people.[2] Thirty years earlier, the population was probably well over 50,000 if one might judge by the outputs, but no records are available.

In 1818, the country came under the direct control of the Netherlands Government, but the Chinese refused to submit to any outside dominance and took up arms to defend what by that time they had come to regard as their own territory. A desultory warfare was maintained for about thirty years, as the Government could not spare the troops necessary to effect a decision. However, in 1850, it became possible to put

[1] "Borneo, its Geology and Mineral Resources," English translation, Dr. Th. Posewitz, 1892, p. 313.

[1] "De Westkust van Borneo," de ned Hermes, 1826, III.

[2] "Westerafdeeling van Borneo," Prof. P. J. Veth, 1854.

a sufficient force in the field and, by 1854, the Chinese were completely subjugated. They were brought under direct European control, but were allowed to retain their own headmen and a restricted measure of their organization.

Mr. R. Everwijn, a Government mining engineer, was sent to the fields in 1854 to report on the possibilities of a copper mining industry ; for, in addition to the gold dust, a considerable amount of copper in the convenient form of slugs of native metal had been recovered from the diluvial deposits and the Government had thoughts of establishing a local mint for the production of a copper coinage. However, Mr. Everwijn's reports were not encouraging and the Government made no further attempts to examine the mining possibilities of the fields for a number of years.

Meanwhile, the Chinese who had come safely through the war had started mining again, although they were short of both money and labour. They gradually made up lost ground and again became wealthy and arrogant, although on a much smaller scale than before. They still resented being under Dutch rule and their resentment culminated in another rebellion, which broke out at Mandor in 1880. The fighting lasted until 1885, by which time practically all the Chinese had either been killed or driven out of the country, thus concluding a long and interesting chapter in local history.

Mr. C. J. van Schelle, a Government mining engineer, had been employed between 1880 and 1887 in making a further examination of the mining possibilities of West Borneo, but his reports were not particularly favourable.[1] After the country had settled down again, the records of production from these fields induced several European concerns to embark in prospecting operations. At Loemar in the Sambas district, the Borneo Company began mining a deposit of gold-bearing rock which had been uncovered by the Chinese. The gold content was low, but it was amenable to direct cyanide treatment at a small cost, and handsome profits were maintained for a number of years.

Alluvial mining ventures were not so successful. At Pengkalen Batu, about 1900, a company named Alluvia, Ltd., carried out some boring and pitting tests and then installed what was termed a suction dredge. It consisted of a steam-driven 12-inch gravel-pump and a monitor pump mounted on a wooden pontoon, which rested on a levelled

Sketch Map Showing Position of the Gold Area in Dutch West Borneo.

[1] Jahrboeken van het Mijnwesen in Nederlandsch-Indie, 1880, et seq.

site on the floor of the paddock. The ground monitored down from the face was pumped to a sluice-box erected on trestles above surface level, near the edge of the working. When it became necessary to move the plant, the paddock was partially flooded so as to float the pontoon, which was then ferried to its new site. Unfortunately, the pontoon had been built of soft local wood. After about a year of service it deteriorated and became so sodden that it would not float, which resulted in the failure of the venture. It is reported that the average depth of the ground was 40 ft. and the recovery was 12d. per cubic yard, but expenses were high and no profits were made. The gold was fine, but " heavy " and easy to save.

Not long afterwards, a European company was formed to start a hydraulicking mine at Empalai in the Landak district, but funds became exhausted before the long ditch for the service water had been completed, and work ceased in 1904.

Two bucket dredging ventures were also disappointing. In 1900, the Melawi Dredging Company obtained extensive concessions on the Melawi River, one of the principal tributaries of the Kapuwas River, an important waterway navigable by shallow-draft steamers. In 1904, a small bucket dredge was towed upstream some 200 miles to the scene of operations and preparations were made to start work. However, while the dredge was still in the main stream it was capsized and wrecked by collision with a large timber raft, which came charging down on the current, a disastrous end to the undertaking.

About 1910, a small dredge with 5 cub. ft. open-connected buckets started operating at Gawang, on a tributary of the Landak River, with a staff of no less than 19 Europeans. Work was carried on for some time, with a reported recovery of 15d. per cubic yard, but, owing to the small yardage treated and the high running cost, expenses were barely covered. Operations ceased suddenly when all hands fled to the coast on learning that a neighbouring tribe of Dyaks had risen in revolt. The dismantled pontoon was afterwards brought down to Pontianak by river and sold.

The general dislocation brought about by the world war in 1914 stopped all mining activities. Since then, the only occurrence of any note was the flotation some six years ago of a Singapore company, which was formed to locate and work dredging and other mining areas at Mandor. Investigations regarding the reliability of some prospecting returns undermined public confidence in the venture and the property passed into the hands of a receiver. Except for some gold-washing by natives, the fields are now deserted.

Prospects for Further Work.—The Chinese worked out practically all the gold-bearing ground which could be drained by them, amounting to some thousands of acres. They had no means of pumping other than their primitive wooden chain-pumps, which were driven by man-power treadles or by small waterwheels, and large areas of waterlogged flats remain untouched by them. There is little doubt that, in years to come, parts of these areas will be worked by means of up-to-date bucket dredges of large capacity. As a parallel case we have the tin fields of Malaya, where similar flats not workable by Chinese methods lay untouched for many years, until modern mechanical developments made their exploitation possible.

The type of bucket dredge equipped with jigs, which has been so successfully evolved in Malaya during the last few years, should prove equally suitable for West Borneo. Cooley jigs should save gold just as well as tin ore, provided that the ragging beds are made up of steel balls instead of the sized pebbles of hard hematite used on Malayan tin dredges. Compared with " tables " or sluice-boxes, jigs show a considerable saving both in labour and in running time, while the recovery is just as good, if not better.

During the last twenty years or so, West Borneo has become much more settled. Roads have been made and transport facilities have improved. The principal port is Pontianak, which is exactly on the Equator. It has a post and telegraph office, banks, hotels, and other conveniences. It is about 30 hours' run by steamer from Singapore, and there is a good regular service.

Origin of the Deposits.—The origin of the extensive diluvial and alluvial beds was first explained by Mr. L. Horner, formerly chief Government geologist, whose theory is now generally accepted. He pointed out that numerous soundings proved the Riouw-Lingga archipelago (near Singapore, and due west of Borneo) to consist of a series of mountain tops, the bulk of the mountains themselves being under the sea and radiating from a central mass, after the fashion of the tentacles of an octopus. He considered that

Borneo was of the same formation, and that the first step in the creation of the present island had been the raising of the land above the sea, exposing a series of mountain ranges radiating from a common centre, and an irregular coast line with large indentations or bays, into which poured rapidly running rivers.

The next step was a still further raising of the land. This was the period during which the extensive diluvial or drift deposits were formed by heavy scour from large areas, which covered the flanks of the lower hills, filled up depressions in them, and spread out beyond them in sloping plains to the coast. Subsequently, the rivers cut through the diluvial beds, sometimes leaving high banks, and continued to carry down large quantities of detritus, which silted up the bays and created wide alluvial flats. The island still retained its octopus-like mountain system, but the bays had been filled up and the coast line had become much more rounded. Clay is noticeably absent in the alluvial beds, which is taken as an indication that they were deposited at or under sea level, the clay carried down with the rest of the detritus having been washed away.

In the "Chinese Districts" most of the gold was won from the diluvial beds, which were more easily drained and worked than the later alluvial deposits. The country rock is known as "Old Slate Formation," which is classed as being of Devonian age. According to Mr. C. J. van Schelle, it consists of clay slates and quartz schists, quartzites and sandstones, argillaceous sandstones, and isolated beds of conglomerate, which are pierced by granitic and dioritic rocks.[1]

Several veins and dykes were worked for gold to shallow depths by the Chinese, but these occurrences are not regarded as of any great economic importance. Some sandstone and conglomerate beds have gold disseminated throughout them and it is possible that deposits such as that at Loemar, which the Borneo Company found so profitable, may yet be found. The bedrock underlying the diluvial and alluvial beds is always soft and decomposed, forming a very suitable bottom for bucket dredging.

Conditions in Dutch Borneo.—As the Law stands, only foreigners who have obtained qualifications (Acte van Vestiging) after a residence of ten years, or Dutch subjects, syndicates, or companies may hold mining land. However, British and other foreign companies operate in the country without hindrance or difficulty through Dutch companies registered in the Netherlands East Indies, all the shares in which are held by the foreign companies. The Government insists on all the books of a company being submitted to them each year for inspection, together with a properly prepared balance sheet. A meeting of the Dutch company has to be held at its registered office at least once a year.

"Vergunningen," or prospecting licences, are granted for three years, with the right of renewal for a further two years, at an annual rental of 2½ guilder cents per hectare (1d. for 5 acres). Concessions, or mining leases, over selected parts of the prospecting areas can then be obtained for a term of 75 years, on the production of proof that any specified metal or mineral can be produced at a profit. The yearly rent for a concession is 25 guilder cents per hectare (2d. per acre). Four per cent of the value of the metal or mineral mined, *less* the actual cost of production and transport, is charged by Government when this amount exceeds the rent for the concession, in which case a rebate of the rent is granted. The minimum Government revenue from a concession is the annual rent, but it is not imposed when a mine is making good profits, and pays 4% of them to Government, amounting to more than the rent. These terms are very reasonable compared with the royalties and rents charged in other countries. Other Government imposts are poll-tax, income-tax, import duties on foodstuffs, stores, machinery, etc., from overseas.

A prospector may freely dispose of the metals and minerals recovered by him. The holders of surface rights are bound to permit prospecting or mining within their holdings, but have to be compensated for any actual damage or obstruction. In Dutch West Borneo very few surface rights are encountered, rates of compensation are low, and this matter is relatively unimportant as compared with the conditions in Siam and other closer-populated countries. It is curious that this territory, which was such a large mining field with such a wonderful record of production in the past, has not received more attention of late years, in view of the marked advancement in dredging and other mining practice, the improvement in local conditions, and the growing demand for gold.

[1] Jahrboek van het Mijnwesen in Nederlandsch-Indie, 1886.

UGANDA

By E. J. WAYLAND, A.R.C.Sc., M.I.M.M., F.G.S.

(*Continued from the January issue, p. 15.*)

The *G1 granite* is often highly foliated and gneissose, particularly towards the edges of the arena floors and was originally thought to be pre-K.A. in age, while the *G2 granite*, which has been in several places observed running up into the arena wall, and is clearly intrusive into the phyllites is regarded as the Newer Granite. Combe has now proved that much, if not all, of the G1 granite is similarly intrusive, and although it is possible that some of the rocks mapped in with the G1 granite may be pre-K.A., it is certainly not true of the mass of it; while G3 does not; and it is tempting to suggest that the intrusion of the G1 and G2 granites occurred at the same time as the folding, while the G3 appeared after the folding was completed (Fig. 11).

Typically the G2 granite is one of normal texture, medium to coarse grained, grey in colour, and porphyritic. It is essentially a biotite granite containing a little muscovite which varies in quantity from place to place, the felspars are microcline and microperthite. The *G3 granite* is a coarse grained aggregate of quartz, white felspar, and

Fig. 7.—Typical Topography of the K.A. Phyllites, near Mbarara.

and Groves has shown that the G1, G2, and G3 granites are co-magmatic. It would appear that much of the G1 and G2 granite is of contemporaneous origin, while G3, which also occupies part of one of the arena floors—though its extent is very limited compared with G1 and G2—and can be seen in some places piercing the phyllites (and also the G2 granites) in dyke-like fashion, is clearly younger, though probably very little younger, and may well belong to a late phase in the consolidation of the mass of the G2 granite. G1 and G2 show strong crushing effects (in places G2 is transformed into a quartz-sericite-schist), muscovite, in roughly equal proportions. Occasional flakes of biotite are present (Fig. 12). Locally the rock becomes very coarse and grades into a pegmatite in which individual minerals measure an inch or so in diameter, and the muscovite occurs in books. In addition to the essential minerals, black tourmaline, and beryl occur in some places in giant crystals. The granites are important because in their acid apophyses tin occurs, sometimes in masses and blebs of cassiterite weighing 100 lb. and more. The mineral is particularly free from arsenical associates and, generally speaking, tourmaline, although of wide occurrence and

strongly developed, is not characteristic of the productive lodes. Some topaz occurs locally.

A full and detailed description of the geology of the stanniferous areas and of the lodes of Uganda by A. D. Combe, will very shortly be published in memoir form by the Geological Survey of the Protectorate. Although the tin occurs in several different ways, one may say that it is generally found in quartz-mica rocks (at one time thought to be pegmatites, but now known to be altered country rocks) sericitic bodies, and in quartz veins. In the latter it is sporadically distributed. Tin mining has not yet reached an advanced stage in Uganda; with a composition corresponding to the formula $Bi_2O_3(Ta, Nb)_2O_5$. It is a grey-black to pitch-black, apparently orthorhombic, mineral, with specific gravity of rather more than 8. It occurs in large misshapen crystals, some of them weighing several pounds, in a pegmatite, and is associated with a lithium mica. At present it is only known in one locality (Gamba Hill) some 35 miles N.W. of Entebbe; but it cannot be claimed that the area has been exhaustively searched. Only a few tons have been shipped.

The next beds in order of antiquity are the *sandstones and quartzites of Butulogo, Mitiyana, and Bukoba.* The first of these are exposed some twenty miles to the north-

FIG. 8.—THE MOUNTAIN WALL OF RUAMPARA—A K.A. QUARTZITE BED, WHICH EXTENDS FOR SOME 200 MILES WITHOUT A BREAK.

and at present the yearly exports amount to only a few hundred tons (Fig. 13).

In the impenetrable forest of Lubugole, north-west of Kabale (in the south-west of the Protectorate), the K.A. rocks are pierced by quartz dykes and dolerites. Some of the former have been proved to carry gold in promising quantity, and in some of the streams coarse, and in some cases very coarse, gold has been proved by a prospector. At present, however, the economic possibilities are not properly known, but work in this area is proceeding. The quartz lodes appear to be associated with the G2 granites.

An interesting mineral, one new to science when it was discovered in 1928, is bismutotantalite, an analogue of stibiotantalite,

east of Mubende township; the second some thirty miles to the east of Mubende, near Lake Wamala; and the last at Sango Bay in the extreme south-east of the Protectorate. All are unfossiliferous, folded into gentle synclines, and possess some other features in common. They are, therefore provisionally lumped together; but they may represent two or even three distinct groups. The most extensive is the Bukoba series, which continues southwards far into Tanganyika territory. Each of these three developments is, as the names imply, characteristically silicious, but shaley partings occur and in the Bukoba series, at any rate, there are ferruginous members strongly resembling the Banded Ironstones of Rhodesia, and elsewhere in South Africa.

They appear to vary from a few hundred to two thousand feet or so, in thickness. The Bukoba series, which has been seen resting unconformably on K.A. rocks, and which has been proved post-G2 (and is doubtless post-G3) granite in age, carries sills of dolerite (presumably Karroo), and the whole is block faulted, with the production of horsts. The beds are likely to be Waterberg in age, but misconceptions on this point, and on some others, led to a good deal of futile coal-prospecting among them in German East Africa before the war. From the point of view of building stone and water supply they are important, but they have not yielded economic minerals in workable quantity.

Next come the *Karroo beds* of Entebbe, and of Bugiri in the Eastern Province. They occur in basins and are of unknown thickness. In Entebbe it would appear that, unless duplication by faulting has occurred, they are over 1,000 ft. thick and consist of clay-shales with arenaceous and calcareous partings. On some horizons they are highly pyritiferous. While light-coloured and frequently brown near the surface, where they have suffered alteration, they are typically grey to black in depth, and while some zones are highly carbonaceous and others contain conspicuous quantities of soluble hydrocarbons, no coal seams have been found beneath Entebbe, but coal partings occur. The possibilities have not, however, been completely explored. Very little is known of the sequence at Bugiri where, as in Entebbe, the beds lie beneath a thick lateritic blanket. Lines of shallow core-bores would do much in this area to determine the nature of the deposits and their economic possibilities. A small fossil flora has been recorded from the Entebbe beds, and indicates an Ecca horizon. Both at Entebbe and at Bugiri the upper limits of the concealed outcrops are determined by the third peneplain. If Karroo beds were searched for and found below the surface of the second or first peneplain, it is probable that higher horizons in the sequence might be found. The matter should receive attention when coal-prospecting is undertaken. In the Bugiri area dolerites occur, and some of them appear to be of the nature of sills. This district experiences annual droughts, and it is interesting to note that the jointed dolerite sills form water bearing horizons under the impervious clay shales—a fact that may prove of considerable importance in opening up this part of the country. Although peneplanation probably took place after the Basal Complex came into being and before the K.A. beds were laid down upon it, and again after the great folding movements that affected the latter, and before the succeeding sandstones were deposited, and yet again after the hardening of these and before the Karroo deposits accumulated, these events occurred so far back in time as to be only geologically significant, but the great peneplanation which succeeded the folding of the Karroo beds is an effect of the profoundest importance in the economy of Uganda to-day.

Exactly when this peneplanation started there is, at present, no known means of telling, but the process must have been one of very long duration, and the base-level of erosion appears to have been the ocean for, according to Professor Bailey Willis, the plateau can still be traced, with ever decreasing altitude, to the sea-board in Tanganyika Territory. There can be no doubt that it is a true peneplain and that it has been gently warped and elevated. It is orthodox to believe that peneplanation can only come about during a period of almost complete tectonic rest. I venture to think, however, that large-scale upward movement, albeit gentle, though intermittent or continuous, is necessary if the prolongation of erosive activities is to result in the removal of all but very minor irregularities, and produce so perfect a peneplain as that with which we are dealing. This conception, moreover, satisfies the requirements of isostasy. The great upheaval of the peneplain, as distinct from the gentle rising just visualized, can only be dated on general grounds, but it would appear extremely probable that it took place in late Cretaceous or early Tertiary times.

Reference has been made to the blankets of lateritic ironstone which mask so much of the solid geology of the country. These blankets are typically developed on the first, and subsequent post-Karroo peneplains, where, for the most part, they have formed in situ, as witnessed by quartz stringers running up into them from the live rock beneath. In some areas, at any rate, lateritization has probably proceeded almost, if not quite, as far as controlling conditions permit, but the process is still active elsewhere, as can be clearly demonstrated in the case of certain alluvial deposits. There is thus a distinction (in no way a profound

one) between high and low level laterites ; but their modes of origin are identical, for they are brought into being during a long succession of alternatively wet and dry seasons by chemical and physical changes, and transferences, resulting from the movements of sub-soil waters which, in consequence of a flat topography, are vertical rather than horizontal.

Much of the lateritic material on Peneplain 1 has been dispersed by denudation ; it is well developed on Peneplain 2, and it is of wide-spread occurrence and commonly thick (40 ft. of it is known on Nsumazi hill, Entebbe), while on Peneplain 3 it is, as a rule, relatively thin. When only one peneplain was recognized, one spoke of pre-plateau areas for exploitable bauxite and manganese deposits.

The flatness of the blankets not only simplifies problems of modern communication, but it has done so in the past ; and it is, perhaps, not entirely without significance that a certain stone-age culture (the Magosian) of Uganda, of rather late appearance, is much more closely allied to its analogue in Southern Africa (later in point of time) than it is to its equivalent in Kenya Colony. Nor is it unthinkable that the relatively high civilization of the Buganda, which early explorers discovered and commented upon, resulted in part from natural facilities of internal communications. But the very factor that brings about the

Fig. 9.—Smelting Iron in the Kegezi District.

and post-Peneplain geology, and while regarding the distinction as fundamental, the lateritic blanket was given formational importance. These blankets are of immense value to the Protectorate by reason of the utility of their material in road making, and in final analysis they help to explain the marked difference in quality between the roads of Uganda and Kenya ; for although this material is not completely lacking in the latter Colony, the want of it in the best farming districts would appear to be one of the causative factors in the road policy of that country. Locally the lateritic mantle is sufficiently rich in easily reduced iron (limonite) to provide ores for native smelting ; and in countries more accessible to markets it would be advisable to search some of the advantage the peneplains bestow is that which renders mineral exploration difficult and tedious, for the blankets mask the underlying rocks, whose nature can only be determined by a careful study of the lateritic materials covering them, or by excavation. By the former means the Karroo deposits of Entebbe and Bugiri were discovered, but studies are not invariably helpful in this manner, for over large areas (parts of the Eastern Province for example) the blankets are not distinctive of the solid geology immediately beneath, because they consist of lateritized Pleistocene alluvials. It is clear, then, that a prolonged study of the lateritic deposits is a pre-requisite to the full understanding of the geology of the Protectorate.

(To be concluded.)

LETTER TO THE EDITOR

The I.M.M. Benevolent Fund

SIR,—Knowing the interest you take in the welfare of members of the mining profession, I venture to ask you to grant me a little of your valuable space to call the attention of your readers to the claims of the Benevolent Fund of the Institution of Mining and Metallurgy. Though in these difficult times the fund has been supported generously by many mining companies and individual members of the profession, the claims for assistance from widows and incapacitated members are severely straining its resources. I am confident that there are many who would be willing to support the committee of management by their contributions and that it is only necessary to bring to their notice, through your MAGAZINE the pressing needs of the fund to secure their co-operation. A copy of the last annual report will be sent on application to any reader who may be interested and all contributions will be acknowledged in THE MINING MAGAZINE.

HUGH F. K. PICARD, Chairman.

Cleveland House, 225, City Road,
London, E.C. 1.
January 25.

BOOK REVIEWS

Flotation. By E. W. MAYER and H. SCHRANZ. Paper covers, 593 pages, illustrated. Price RM. 33. Leipzig: S. Hirzel.

It is seldom that a scientific worker is called upon to review a book which gives him almost entire satisfaction, but such is the case with the present work. If the satisfaction is not entire, it is because, first, the book has not been written by one of the original British pioneers in flotation work and, secondly, because of difficulties with the German language, which have, at times, prevented its full enjoyment. An eight-page English-German vocabulary of technical terms, however, forms a useful item in the book. This vocabulary is followed by a twenty-six page bibliography of recent articles on flotation, and comprehensive author, and subject, indexes. These last items are mentioned first because they indicate how efficiently the book caters for the practical man who wishes to look up some matter of particular interest to himself, as well as for the person who wishes to acquaint himself with the present state of knowledge on the subject. In addition, the list of contents follows the very desirable, and increasingly common, practice of giving an ample summary of the contents of each chapter.

Definitions, history, and the application of flotation are dealt with in the first sixteen pages, the author then proceeding directly (pages 17 to 202) to the consideration of the machines and apparatus used. All that can be said of this section is that the treatment is adequate and that the figures and illustrations are numerous and exceedingly good. The illustrations, for example, Figs. 101 and 110, have a boldness of outline and a clearness of detail, which indicate the perfection of some new process of reproduction. The printer, as well as the author, has contributed materially to the excellence of the book.

The theory of flotation is then dealt with under procedure, reagents and their effects being included in this section (pages 203 to 294), and the author shows himself thoroughly acquainted with the most recent work published. This point is emphasized by the fact that results published only a few months before the printing of the book are included. The use of curves for summarizing experimental results is much favoured by the author.

The treatment of ores, including graphite, sulphur and native metals is next dealt with (pages 295 to 475), and the flotation of coal (pages 475 to 521) is given special notice.

The concluding section (pages 522 to 567) appropriately deals with miscellaneous items, such as the vocabulary and bibliography already mentioned; flotable minerals, their composition and properties; the more important patents dealing with flotation, etc. With the application of flotation to the separation of non-metallic minerals and to products in chemical technology, it seems that this book should be of great value to a large number of workers in mining, metallurgy, and chemical engineering. It is to be hoped that an English, or American, translation will be available at as early a date as possible.

B. W. HOLMAN.

Principles of Structural Geology. By Dr. C. M. NEVIN. Cloth, octavo, xi + 295 pages, illustrated. Price 17s. 6d. New York: John Wiley and Sons; London: Chapman & Hall.

With a prefatory tribute to the influence of Van Hise, Leith, Chamberlin, Willis, and Lahee, the author approaches his subject in a way which is both original and direct. Reviewing first the physical properties of solids under stress, he proceeds to a detailed treatment of the stress-and-strain relations and the corresponding ellipsoids, to which constant appeal is made in the later discussion of crustal deformation and rock-failure. The author's outlook is defined by his rejection of any theory which uses a contracting earth to generate compressive stresses; he considers that the attitudes assumed by near-surface sediments are determined by differential deforming stresses which originate in, and are transmitted from, the relatively rigid basement complex on which the sediments rest. Mathematical treatment gives place to reasoning from first principles based on applied mechanics and directed not only to interpreting the more commonplace units of geological structure, but also to co-ordinating major features with minor details liable to be overlooked.

The second half of the volume deals with unconsolidated sediments, rock-structure in relation to topography, and the various hypotheses regarding isostasy, ocean basins, continents, continental drift, orogeny, etc. Problems still in dispute are not avoided on that account; on the contrary, the author turns to them for the purpose of presenting various view-points and of stimulating independent judgment. Among the topics thus selected are doming, jointing, rift-valleys, torsion, zones of folds and fractures en echelon, nappes, and lateral-spreading batholiths with floors and other laccolithic features. Though the author does, on occasion, reveal his own conviction (for example, that doming is the effect of dominantly vertical stress rather than of cross-folding) the dogmatic manner is wholly absent; the limits of positive knowledge are frequently, and frankly, declared; for instance, he concludes a review of the case for rift-valleys by remarking that "some say trough-faulting represents a true sunken block; others maintain that the sides rose; and still others straddle the issue and suggest that both movements are represented. The truth of the matter is, we do not know. One theory after another . . . has proved too small to fit the facts." Nevertheless, he brings to bear on these unsettled problems many new and constructive ideas.

The subject-matter, which is comprehensive, is accorded well-proportioned treatment; sequence, printing, and illustrations are alike excellent. Altogether the volume is lucid and stimulating from cover to cover.

A. BRAMMALL.

Geology of Petroleum. By W. H. EMMONS. Second Edition. Cloth, octavo, 736 pages, illustrated. Price 30s. London: McGraw-Hill Publishing Co., Ltd.

The second edition of this well-known textbook contains many additions to, and improvements on, the first edition, which entitle it to retain its place as one of the best and most comprehensive works on the subject. This edition is actually more than a mere textbook, and will also prove a valuable book of reference for the qualified oil geologist. The material in the book has been brought up to date, not only with regard to the geology of the oilfields of the world, but also with regard to the present day views regarding the important but controversial subject of the origin of oil. It is an excellent work.

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

December 22.

Mount Isa.—The report of Mount Isa Mines, Ltd., for the year ending June 30, which has only lately been made available here, does not contain much information that has not already been published. The balance sheet shows that the expenses for the year were £573,733, and that this amount includes £408,961 spent on prospecting and development and £138,772 in interest on debentures. A debit of £532,027 at profit and loss account has been transferred to the

prospecting and development account, making that item in the balance sheet £1,196,098. The annual meeting of the Mount Isa Mines Co., which was to have been held in Sydney on the 9th of this month, lapsed for want of a quorum, but the chairman of directors (Mr. R. W. M'Rea) made a statement to those shareholders who were present in which he stated that when the third smelter, with the necessary sintering plant, was installed, it is confidently expected that the production of bullion will be about 6,000 tons a month. He mentioned that the willingness of the American Smelting and Refining Co. to advance up to 1,000,000 dollars (£200,000), to extend the plant, was sufficient evidence of their confidence in the soundness of the mine, and said the directors were now able to state that the unforeseen difficulties attachable to such a huge undertaking are controllable. Mr. J. P. B. Webster, a director of both Mount Isa Mines, Ltd., and the Mining Trust, was in Brisbane a few days ago, on his way, by air, to Mount Isa. While he was here, the first steps were taken towards transferring the head office of the former company from Sydney to Brisbane. This company, with a nominal capital of £10,000,000, has been formally registered in Queensland, but it will take several months before the actual transfer of the office is finalized. Technically, the company registered in this State becomes a new one, but the name remains the same, as will also the shareholders and debenture holders. For the time being there will only be three directors—namely Messrs. J. P. B. Webster, J. Kruttschnitt (General Manager at Mount Isa), and Ellison Macartney, of the firm of Thynne and Macartney, the company's solicitors in Brisbane. It is probable that additional directors will be appointed when the complete transfer of the office has taken place. Administrative work, it is stated, will be conducted at the mine.

Queensland Company Laws.—It is interesting to note, in connexion with the intended change of locale of the head office of the Mount Isa Co., that this intention has been brought to a head by legislation just enacted by the Queensland Parliament. The original Mount Isa Syndicate, like many other companies holding interests in this State, was registered in New South Wales, where the company laws, stamp duties, etc., have been more favourable than here, but the Act now passed has liberalized matters in this regard, and will permit of such companies being registered in Queensland, with attendant benefit to the Northern State.

Operations at Mount Isa.—According to official records, during the past six months the smelter at Mount Isa has produced 13,626 tons of lead and 836,565 oz. of silver, the total value of which was £230,681. In each ton of bullion there was an average of 60 oz. of silver. Since the beginning of smelting (on June 8), the average monthly price of lead has increased from £11 15s. 4d. a ton to £14 11s. 4d., while the quotations for the metal this month have topped £15 10s. Silver, too, after reaching low levels previously unknown in history, has risen from an average of 1s. 1d. an ounce for June to over 1s. 7d. for November. Additional sintering equipment is being added at the mine and it is expected that the output will be increased to 4,000 tons of bullion a month by the end of February next. When a third smelter has been installed, with the necessary sintering plant, the expected output will be 6,000 tons monthly, the full capacity of the plant. Mr. Webster states that this full capacity will not be reached till next June, and that any further increase after that will depend on the general economic position and metal prices. In underground work, on the Black Rock lode a foot-wall drive was in November being put in on No. 3 level, in order to permit of a scraper loading the broken ore from the stope. In this section, Nos. 3 and 4 levels on the main lode are being connected by means of a winze from the former and by a rise; while a cross-cut is being driven westerly from the main drive in order to intersect an ore-body located in No. 640 west lode. In the Rio Grande section the erection of the automatic winder has been completed, and the plant in November was being tested. The two stopes on the main lode at No. 1 level, which have been operated continuously, are nearing completion. At the same time, the main lode (south) stope is now ready for stoping, and a drive is being extended to develop the pyritic lode on the hanging-wall.

Mount Morgan.—The report to be submitted to the second annual meeting of Mount Morgan, Ltd., to be held in Sydney on December 30, has just been published. According to this report, which is for the period ended June 30 last, the total revenue for the year from all sources was £14,972, and the expenditure, including depreciation, £19,408, a net loss being thus shown of £4,435. At the close of the term, however,

there remained on hand 30·69 tons of copper, which had been valued at £40 a ton. The copper precipitates shipped overseas realized an average of £42 1s. 11d. per ton of copper. Expected results from development, through unforeseen circumstances, had not eventuated. When these are attained, it is considered, the original estimate of 14 tons a week will be exceeded, and give a fair margin of profit. The bulk sample of readily accessible ore sent to New York for treatment, it is stated, proved highly satisfactory, and the results obtained were confirmed by independent laboratory tests. Just now, also, a thoroughly representative parcel of this class of ore is being treated at Mount Isa. This consists of 24 tons characteristic of the ore from the Linda level (38 floor) upwards and representative of about 600,000 tons that can be worked by open-cut. Mr. A. A. Boyd, the managing director of the company, taking as a basis the results reported by the American Cyanamid Co., with gold at 85s. an ounce and copper at £40 per ton, makes the net profits expected from the working of the ore-body come to 6·363s. per ton of ore, without taking into consideration the enhanced price of gold or any benefit from the favourable exchange position or gold bounty.

Western Australian Gold.—For the first 11 months of 1931 the gold output of Western Australia was 46,356 oz.—an increase of 87,084 oz. compared with the return for the corresponding period of 1930. The yield for November (53,860 oz., valued at £228,823) was the highest monthly return since that of November, 1920. The output for the year 1929 was 377,176 oz., and that for 1930, 416,369 oz.

Wiluna Mine.—Mr. C. Lindberg, who was commissioned by Wiluna Gold Mines, Ltd., Western Australia, to make an investigation of the surface and underground positions of the mine, has issued a preliminary report, in which his views are summarized. In his opinion, there is no cause for alarm with regard to an extension of the ore, either in depth or laterally, while the long view ahead is reassuring and possesses elements of distinct promise of better results than those already obtained. At the same time, Mr. Lindberg says, it is recognized that the mine cannot be called upon to deliver more than 25,000 tons monthly until development work is further advanced. Metallurgical investigations are not sufficiently advanced to warrant a definite forecast, but good reasons exist for expecting improved results either by reduced cost or increased recovery.

Broken Hill Block 14.—At the annual meeting of the Broken Hill Proprietary Block 14 Co., Ltd., held in Melbourne recently, the chairman (Mr. Birkbeck) said that the mine had been closed since July, 1930, and that this long non-productive period has brought the company to a point at which its future is causing the directors grave concern. Cash resources, he added, were at a very low level, one of the principal causes of this position being the crushing burden placed on the mining industry by various awards and by the provisions of the Workers' Compensation Acts. Mr. Birkbeck further stated that the only alternative which presented itself to the directors to avoid liquidation was for shareholders to approve of the capital being increased or the company being reconstructed to allow of calls being made as required to finance the company until production could be resumed. Shareholders at the meeting supported a policy of reconstruction and adopted the directors' report.

IPOH

January 15.

Prospects for 1932.—The policy of restriction of output of tin ore has now had nearly a year's trial and it may safely be claimed that it has attained the results aimed at so far as the peculiarly unfavourable circumstances have permitted. Production in this country is now gauged with sufficient accuracy, measures have been taken to prevent privileges granted to meet special difficulties from being unfairly used, and scales of costs have been generally reduced. The privilege of grouping was intended to enable producing mines to combine for economy in winning the total of their quotas, but attempts were made to include in a single group so many mines that the original purposes of the privilege were exceeded. The policy of the Government can be summarized as follows :—(*a*) to qualify for grouping, a mine must itself be capable of producing its full assessment. (*b*) Unless under one ownership or management the inclusion of more than say six mines in one group will not be favourably considered. (*c*) If a mine is unable to produce its already approved assessment, notice of intention to reduce the assessment may be given, and the miners called upon to show cause why their assessment should not be reduced.

Costs and Revenue.—An example of the relation of costs to income in dredging under circumstances involving some difficulties is provided in the recent report of the fifth annual meeting of Malaya Consolidated Tin Dredging at Penang. The report states that the company have four dredges on three properties, but only two properties with one dredge on each have been continuously active producers. The Chemor dredge made a profit of $12,861 (after deducting $2,800 spent on a river deviation) producing pikuls 340 per month at a cost of 10·48 cents per cu. yd., the recovery averaging 0·307 kati per cu. yd., which was 80·82% of the bore values. The Kampar dredge shows a profit of $6,566 for the year averaging pikuls 311 per month at a cost of 13·20 cents per cu. yd., showing a recovery of 0·382 kati per cu. yd., and 84·61% of the bore values. The increased cost in this case is due to the smaller yardage treated. Under the present circumstances this company have obtained approval for grouping with Penawat (Malaya) Tin Dredging, which latter company is to produce the combined output for the present, Malaya Consolidated closing down all units except a magnetic separator plant at Kampar. The above gives a fair example of the application of grouping in the case of dredging companies. Malaya Consolidated in this case can cover monthly maintenance expenses and are conserving the assets represented by their unexhausted ground.

Flood Damage.—Very heavy monsoon rains in December caused such serious floods in Pahang and Kelantan as to put out of use a large proportion of the only lately opened Eastern railway, giving through services from Singapore through Kuala Lipis to the coast of Kelantan at Tumpat. Rivers risen 60 feet and market towns submerged so as to have to be evacuated were among the results recorded on the east side of the main range. On the west side serious damage was done in Perak especially along the Perak River on which the pontoon bridges at Enggor and Parrit were swept away, cutting off all communication by road at those points. The new road bridge at Enggor cannot be ready for some months yet, and it is understood the old pontoon bridge is not to be repaired, so the railway has to be used between Enggor and Kuala Kangsar by all traffic towards Taiping and Penang, or from those places to Ipoh. A special service of local trains is running and cars and lorries can be set down at K. Kangsar to continue their journey by road beyond that point, and conversely. The great dam at the Perak River Hydro Electric Power Company's station at Chenderoh stood this severe test well.

JOHANNESBURG

January 6.

Manganese Industry.—The Manganese Corporation reports that negotiations with the South African Railways Administration are in progress in an endeavour to arrive at a settlement regarding the corporation's liability in respect of guarantees under certain agreements with the railways. This liability is due to the abnormal economic conditions prevailing during the past year, culminating in the exchange difficulties which resulted in the temporary closure of the mines at Postmasburg. The corporation's capital expenditure programme is now completed and the plant at the mine and Durban is capable of dealing with any demands. As the deposits were opened up during the year and their nature became better understood, it was possible by altering mining methods to reduce considerably the proportion of waste to ore and to improve the average grade of production. The consequent improvement in working costs has been remarkable and continued from month to month, until October, when operations were stopped. The directors have been investigating the possibilities of increased sales and further reduction of costs by taking advantage of various favourable factors in different ferro-manganese producing centres and carrying out negotiations to this end. These negotiations are still continuing and are inclining in two main directions—namely, the possible establishment in South Africa of a ferro-manganese producing industry in association with the refining of oil products, whether from imported or indigenous raw materials, and/or the possible linking up with other heavy industries in South Africa and entering into long-term contracts for the sale of manganese ore to Canada in association with the reciprocal trade agreement now under discussion between the Union of South Africa and the Canadian Governments. Working costs are capable of further reduction with adequate outputs, but under present conditions less than 25% of the c.i.f. costs are under the corporation's direct control, the balance being represented by transport, landing charges, etc. Railage from mine to

Durban is responsible for nearly 65% of the f.o.b. costs, and is, therefore, an item of paramount importance. The corporation's agreements with the South African Railways and Harbours were concluded under conditions which no longer prevail. Negotiations are now proceeding with the Minister of Railways for the alteration of the corporation's railway agreements and a reduction in railage rates, and it is hoped that the Government will enable the corporation to restart operations at an early date. Inquiries for ore have been on the increase lately and the directors are confident that the corporation can commence selling, producing, and shipping at very short notice, provided it is granted conditions which would enable it to compete with producers in other parts of the world.

Eluvial Gold.—An interesting report by Mr. V. Grindley Ferris on the eluvial gold occurrence near Kaapsche Hoek, Eastern Transvaal, has been published. It states that 500 claims have been acquired from diggers who for some time past have been working on the farms The Narrows No. 117 and Kaapsche Hoop No. 47, and it is understood that additional claims are being acquired. The report states, also, that the gold is found in gravel which is covered by an overburden of a thickness varying from a few feet up to 25 and 30 ft. in places. It is evident that the gravel is due to local denudation, as boulders with sharp edges are found in it, and some little worn nuggets recovered recently indicated that the gold had not travelled far. The material appears to have been derived from the disintegration of rocks of the Transvaal System, which exists all over that locality, lying upon old granite, although some of the gold may have come from quartz veins in the granite itself, which underlies the eluvial gravel. Most of the area is unexplored and there is little information regarding the yield of the ground, but with regard to the grade of the gravels occurring in the North Central section, there is definite information from Mr. Tope, who is now in charge of the work at The Narrows and who has worked the gravels for various periods since 1914. He estimates his average yield during these years at about 7 dwt. per cu. yd. After taking everything into account, Mr. Ferris says : " With a high grade of 20s. per cu. yd., which, from the information at my disposal seems a likely estimate of the value of the gravels in the North Central Section, substantial profits should be made from the gravels in this area if the treatment can be carried out on a large scale."

Northern Transvaal Copper.—Details of the results achieved by the Elbof Geophysical Prospecting Co. in its investigations on the Northern Transvaal (Messina) Copper Exploration Co.'s property are given in the copper company's annual report. The directors state : " Generally speaking, the geophysical work accomplished has proved considerable concentrations of ore of high grade. These results, added to the positive disclosures already made in our numerous surface cuttings and shafts, undoubtedly prove the importance and potentialities of the copper deposits existing within our claim area. The recommendations contained in the Elbof Company's report for opening up these deposits have been carefully considered, and we are ready to go ahead when conditions permit to put down several bore-holes at various points as a preliminary to locating the best possible sites for shaft sinking. We have also in mind to continue sinking the Scovan shaft, from which two shipments of high-grade ore were made to New York, as mentioned in last year's report."

Rhodesia's Mining Laws.—Southern Rhodesia's proposed new Mining Law, which is to be introduced in the Legislative Assembly in March next is a comprehensive measure of 39 clauses, reviewing and revising many provisions of laws dating from 1903. It is largely designed to bring the law up to date to match present conditions and to remove anomalies in the old laws. Express provision is made for the payment to the British South Africa Co. of specified royalties on certain minerals, coal, mineral oil, and natural gas. Provisions which may lead to some conflict between farmers and miners are those relating to wood-cutting and water rights conferred by the Bill on the miner. Beyond these features the measure contemplates few changes in the prevailing legislation, excepting that considerable use is proposed to be made of arbitration machinery, where disputes arise between miner and landowner.

VANCOUVER

January 9.

Production in 1931.—A preliminary report has been issued recently by the Minister of Mines, embodying a statistical review and summary by J. D. Galloway, the Provincial Mineralogist, and reports by the

several Resident Engineers of the Department. The final figures for production for 1931 are given by the Provincial Mineralogist as follows :—

Product.		*Quantity.*	*Value* $.
Gold, lode	oz.	152,000	3,142,137
Gold, placer	oz.	13,529	230,000
Silver	oz.	8,200,000	2,331,096
Copper	lb.	68,150,000	5,554,225
Lead	lb.	264,280,000	7,309,456
Zinc	lb.	202,000,000	5,230,386
Coal, tons (2,240 lb.)		1,700,000	8,500,000
Structural Materials			3,600,000
Miscellaneous Metals and Minerals			670,000
Totals			$36,567,300

It is pointed out that owing to the fact that the large operating companies confined themselves almost exclusively to gold properties, general mining development was retarded during the year. An exception to the curtailing of development programmes is noted in the case of Britannia Mining and Smelting Co., which commenced the driving of a new 10,000 ft. haulage tunnel during the year, evidencing an assurance in the future that is particularly encouraging. There were a great many prospectors out in the hills and several leasing operations on abandoned properties were undertaken. Particularly in the field of placer mining, impetus has been given by the employment of many men thrown out of work by the industrial depression. Dividends for the year were estimated at $4,750,000 as compared with $12,527,652 in 1930, but it was pointed out that a considerable proportion of the sum mentioned was derived from reserve funds rather than from current operating profits. The reports of the Resident Engineers, which accompany the review, give full particulars of all the important activities in the province.

Stewart.—Interesting information with regard to the operations and prospects of B.C. Silver Mines, Ltd., was given by the President, C. A. Banks, at the Annual Meeting of the company held in Vancouver on December 30. Operations at the property adjoining the Premier Mine in the Portland Canal District were suspended early in the year, after a thorough resampling of the ore-bodies. Previous to this temporary stoppage of work, development had been continued upon the known ore zones on the northern group of claims including 420 ft. of driving, 209 ft. cross-cutting, and 304 ft. rising, and a considerable amount of testing work was done to determine the width of the ore-bodies by drilling into the walls. The result of all the more recent work was to confirm previous estimates of values and to indicate greater widths of economic mineralization. Particularly encouraging results were obtained in the work above No. 6 level on the " B 2 " zone, where sampling in a 50 ft. rise and along a sub-level carried for a distance of 130 ft. showed considerably higher values than were obtained on the tunnel level. Good stoping ground was to be expected between this sub-level and the No. 5 level above. A well mineralized zone was also indicated as a result of work carried out above the No. 3 level on the " C " ore zone, but this development did not open up any high-grade ore. Further steps were taken with a view to production in the way of preliminary surveys for a mill site and obtaining assurance of an adequate water supply. Measurements of flow carried out through the winter were stated to be satisfactory. Up to the present time an amount of $845·64 has been expended upon the development of the property.

Anyox.—In spite of a quarterly operating loss of £5.696, plus allowance for depletion and depreciation and federal taxes, Granby Mining Smelting and Power Co., Ltd., declared a further payment out of reserve fund, as " dividend " to shareholders as at January 15. No actual dividends have been earned since 1919, the amounts paid out of reserve fund, commencing with the year 1927, have been at the following rates :—1927, $1·00 per share ; 1928, $3·00 per share ; 1929, $7·00 per share ; 1930, $5·25 per share ; and 1931, $1·37 per share, and represent return of capital.

Trail.—Consolidated Mining and Smelting Co., of Canada, Ltd., has made a further issue of 28,744 shares of a par value of $25·00 to cover bonuses to employees who have completed three years continuous service and a half-yearly dividend of 5% in stock on the paid up capital. In addition 5% in cash was distributed. Recent activities of the company in the field, of some significance in the present market situation, are reflected in the reported acquisition of copper properties on the islands of Oderian and Patricks in Placentia Bay, on the south coast of Newfoundland, where native copper was found by a resident 30 years ago. The company continues to vindicate its position as the pioneer of progress in the full realization of our natural resources and, apart from the metallurgical operations, the huge plants at Tadanac and Warfield constitute a nucleus

of advancement in various directions. The fertilizer plant, embodying the latest discoveries of chemical engineering is producing ammonium sulphate, phosphate, and superphosphate from the air and water. Another recent activity of the company is the manufacture of zinc white from fume.

Taku River.—Work on the Whitewater group, which is under option to Noah Timmins, has been discontinued for the winter. The property is situated on the Tulsequah River about 4 miles above its confluence with the Taku, in the Atlin district. The main showings are at an elevation of only 800 ft. above the river, and consist of outcrops of silicified shear zones in rhyolite and felsite dykes traversing a volcanic formation. Gold values are associated with antimony, which occurs in massive form and also as disseminations in a quartz gangue. The zones vary in width from 3 to 8 ft. and have been traced for a considerable distance. Five diamond drill-holes near the original discovery are said to have afforded encouraging results and further drilling at a distance of 500 ft. along the line of the mineralized zone had been commenced, when work was stopped by severe weather. Some high values are obtained, one sample taken across a width of 6 ft. having yielded an assay of 0·8 oz. gold per ton, with 6% antimony. In the same area the Alaska Juneau Gold Mining Co. commenced surface exploration on the Mineral Mountain, Silver Bird, and Golden Star groups, where similar occurrences are found.

Omineca.—Some promising results have been obtained from the development work that has been carried on at the Cronin mine, owned by the Babine Bonanza Mining and Milling Co., and situated at an elevation of 5,000 ft. in the Babine range. There are two main veins, which pinch and swell abruptly, and several smaller veins containing sulphides of lead, zinc, and copper in a quartz gangue. Ore shoots varying in width from 2 to 12 ft. have been followed for considerable distances and appear to be related to the plunging contact of an intrusive rock with a black argillite formation.

TORONTO

January 16.

Gold Production of Ontario for 1931.—The gold mines of Ontario made a new high record for production in 1931, the output of bullion being $42,696,453 exclusive of premiums, as compared with $35,518,682 for the previous year. These figures include only the production from the gold mines and do not embrace the yield of gold obtained as a by-product from other mining operations. The production of gold in December also established a new high record, with a total of $3,906,464, as compared with a total of $3,866,270 for November.

Porcupine.—The gold mines of the Porcupine area during December produced bullion to the amount of $1,852,621 from the treatment of 265,585 tons of ore, as compared with $1,579,296 from 263,163 tons of ore. The Hollinger is steadily maintaining production and underground developments at the lower horizons are adding to the ore reserves and disclosing conditions which encourage deeper mining. Dome mines during December produced bullion to the value of $291,481, as compared with $251,685 for the previous month, the output for the year being $3,473,942. The difficulties experienced in the extraction of gold have been overcome by changes in the mill restoring the old method of amalgamation and cyanidation, which has materially increased the recovery. Some two months since, an ore zone was located on the 16th level with assays of $15 in gold to the ton. This has been opened up and values are holding up well under development. The new mill of the McIntyre Porcupine is working satisfactorily, handling about 60,000 tons of ore per month, with a recovery of $8 per ton. Number 22 vein in the Platt Vet claim 3,000 ft. south of the main shaft has been opened up on the 3,750 level for 1,200 ft. of which over 700 ft. shows ore averaging $9 over a width of 8 ft. A rise has been put up on this vein to the 3,625 ft. level and is all in ore. The Coniaurum has increased mining operations and established a new record for December, when the mill handled 11,000 tons of ore with a recovery of $8 per ton, resulting in earnings for the month of $93,000. There has been a gradual improvement in the grade of ore going to the mill during the last few months and there is sufficient high-grade ore in sight to keep the mill in operation for three or four months.

Kirkland Lake.—During December, 149,482 tons of ore were treated at the Kirkland Lake mines yielding bullion to the amount of $1,935,220, as compared with 148,500 tons with a recovery of $1,340,816 in the previous month. At the Lake Shore a big programme of development is being under-

taken. Work is now under way for sinking Nos. 1 and 3 shafts to a depth of 4,000 ft. On the completion of the sinking programme the company will have eight new levels for development. The mill is also being enlarged to increase its capacity to 4,000 tons per day. The present monthly production of gold is approximately $1,100,000. Mining operations down to the present bottom workings are proving substantial tonnages of good-grade ore. On the lower horizons the mineral zone is stated to have widened considerably, the average grade of ore being well maintained. The Wright-Hargreaves, by the operation of its new crushing equipment has increased the rate of production to 800 tons per day. The output during 1931 is estimated at $2,800,000. The new high-grade vein encountered on the 2,250-ft. level has been driven on in five levels, opening up about 2,000 ft. of ore, carrying average-grade values. Production at the Teck-Hughes has been light, the management latterly devoting their principal attention to development. Preliminary work on the 31st and the 32nd levels is opening up a good ore section, considerable cross-cutting and driving has been carried out, and the vein system is said to show a width of 14 ft. carrying average values of $17·50 per ton. The shaft of the Sylvanite is now down 2,900 ft., its objective being 3,000 ft. On the 600-ft. horizon the drive has been passing through a mineralized zone, which returned average assays of $15 to the ton in gold, production is being maintained at the rate of about $80,000 per month. The Kirkland Lake gold mine reached a new high level in December with production estimated at about $70,000. Work is being pushed at the 4,775-ft. level with both drives in ore, some of which is high grade. The Barry-Hollinger has completed a winze at the 2,000-ft. level, on which it has opened up high-grade ore. Development work on the 1,875-ft. level has encountered similar ore. The Moffatt-Hall will sink the shaft to a depth of 700 ft. and establish two new levels. The drive on the 425-ft. level is in ore averaging $10 to $12 per ton.

New Goldfields.—While the production of base metals has been much curtailed owing to unfavourable market conditions the gold mining industry is showing greatly increased activity. Prospecting has been carried far and wide, leading to the opening up of new areas and operations have been resumed in some districts which were formerly productive, but which had for some time been abandoned. In the Michipicoten area two mines have reached the production stage. The Minto, which went into production six months ago has so far recovered about $90,000. The Parkhill, which completed the installation of a 60-ton mill a few months ago, is producing about $25,000 per month. The capacity of the mill is to be doubled and the shaft continued from 300 to 600 ft. The Sault Prospecting and Mining Syndicate is developing a claim and will shortly have a test mill in operation. The Lake of the Woods area is also receiving the attention of mining men. The Vickers Mines, Ltd., has taken over the old Ontario Champion property near Kenora and development work has yielded encouraging results. Other companies which have become interested in this field are: The Ribago Copper Corporation, Ltd., the Duport Mining Company, the Kenora Prospectors and Miners, Ltd., and the Beardsmore Gold Mines, Ltd. At Dog Lake in the Algoma district the Consolidated Mining and Smelting Co., which has 37 claims, has a large crew at work and is stated to have opened up several promising gold veins. In the Matachewan area the Mining Corporation of Canada is actively pushing development at the Ashley gold mine at Elk Lake, driving is being carried out on the 375 ft. level, where ore has been encountered stated to show $12 to the ton.

Sudbury.—The International Nickel Co. announces that its operations will not be in any way affected as a result of the agreement of the world's copper producers to curtail production to 40% of their rated capacities as, owing to the restricted demand for nickel, operations have already been reduced to a basis of approximately the ratio capacity set by Copper Exporters, Inc. Operations at Falconbridge Nickel Mines are being carried on at full capacity in all departments. Both the smelter and refinery are handling their maximum tonnage and practically the entire production is being sold. Underground development is proceeding actively with satisfactory results. At the Errington mine of the Treadwell Yukon Co. operations have been discontinued owing to the low price of base metals. This step has been expected for some time as the pilot mill for the concentration of ore has been closed down for more than a year and there has been no income from the sales of the metallic concentrates. The Consolidated Mining and Smelting Co. have acquired additional interests in the Swayze area having staked a group of 17

claims and are carrying on active explorations. Many prospectors are at work in the district.

Rouyn.—Noranda Mines have agreed to cut down the copper production from 60 to 40% of rated capacity subject to certain conditions. The conditions under which the company agrees to curtail are that its output of precious metals remains as at present and that its gold production of slightly more than $5,000,000 be maintained.

PERSONAL

R. A. Barry has returned from West Africa.

J. A'C. Bergne has returned from Northern Rhodesia.

W. A. Bone, professor of Fuel Technology in the Imperial College of Science and Technology, has been awarded the Melchett medal for 1931 by the Institute of Fuel.

H. F. Brown has left for Sierra Leone.

K. O. de Veer is now in Portugal.

W. A. Edwards is now in Bolivia.

J. A. Fawdry has returned to East Africa.

J. E. Halford is returning from the Gold Coast.

R. L. Hewston has returned from West Africa and left for South Africa.

W. D. Hole is home from Mexico.

Arthur Holmes is leaving for America, where he is to deliver a course of lectures on radioactivity and geology.

C. E. Jobling is returning from Burma.

T. P. Larken has returned from Greece.

D. H. B. Leggett has returned to Venezuela.

Brian Llewellyn has left for India.

W. S. McCallum is returning to New Zealand.

William McNeill is home from New Zealand and Mexico.

T. F. O'Sullivan is now in West Africa.

J. W. Park is home from Burma.

John Parkinson has returned from British Somaliland.

C. R. Pinder is home from Melbourne.

George C. Riley is here from Canada.

James Roberts is returning to Italy.

O. A. L. Whitelaw, formerly of the Gold Coast Geological Survey, has left for Australia.

L. M. Winn is home from Northern Rhodesia.

Harley B. Wright is home from West Africa.

Lorens Carlson died in Stockholm on January 29. Mr. Carlson had been managing director of the Swedish Diamond Rock Drilling Company since 1913.

George Ernest Stephenson died on January 26, aged 64. Mr. Stephenson started his mining career in Australia and on returning to England was for some time manager of a lead and barytes mine in the North. He subsequently became manager of the Tronoh Mines, prior to the days of dredging, and occupied a similar position on the Great Fingall, in Western Australia. During the War he was engaged on behalf of the Government in increasing the iron ore output of the Middlesborough district and in managing the Mount Sinai manganese mine. After the War he took charge of the Blackwater Mines, in New Zealand, being there about two years, and then took over the management of the Palmarejo mine in Mexico. During the past few years Mr. Stephenson was employed by the Rio Tinto Company as manager of their Algerian phosphate mines, and for the last two or three years represented that company in Cyprus.

TRADE PARAGRAPHS

Henry Bath and Son, Ltd., of 37 to 39 Lime Street, London, E.C. 3, publish their annual chart showing the movements in the prices of base metals over the past 11 years.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, publish a catalogue of their single-phase motors and starters including squirrel-cage, slip-ring, and repulsion-induction types.

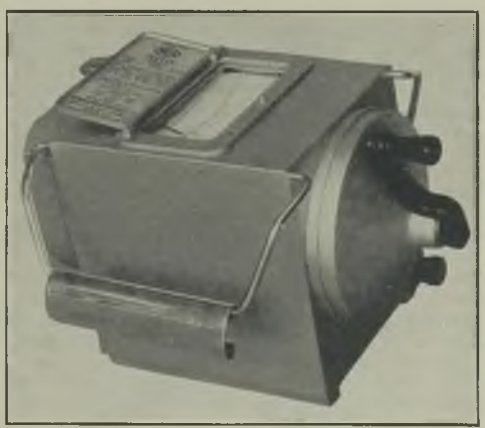
Hopkinsons, Ltd., of Huddersfield, send a booklet describing their steam traps admirably illustrated with cross-sectional elevations in four colours, which serve to explain amply the principles of operation.

G. A. Harvey and Co. (London), Ltd., of Woolwich Road, London, S.E. 7, again write drawing attention to their steel furniture equipment for which there is a considerable demand for use as fittings in offices, works, and suchlike.

Dorr Co., Ltd., of Abford House, Wilton Road, London, S.W. 1, advise that the liquidation of **Oliver United Filters, Ltd.,** is the result of the amalgamation of the two businesses and that steps are being taken to change the name of the company to **Dorr-Oliver Co., Ltd.**

Kinetic Elutriators, Ltd., of 11, Southampton Row, London, W.C. 1, notify the receipt of an order from the Dominion Government (Mines Branch) Laboratories at Ottawa for a 12 in. Andrews classifier received through their Canadian agents, the General Engineering Co., of Toronto.

Evershed and Vignoles, Ltd., of Acton Lane Works, Chiswick, London, W. 4, have made a new addition to their " Megger " series of resistance measuring instruments. This is to be styled the " Meg " earth tester, is designed on exactly the same principle as the " Megger " earth tester, and fulfills a demand for an instrument of lighter weight and lower price. Reference should be made to the Magazine for September, 1929, for a description of the earlier instrument. The new instrument is



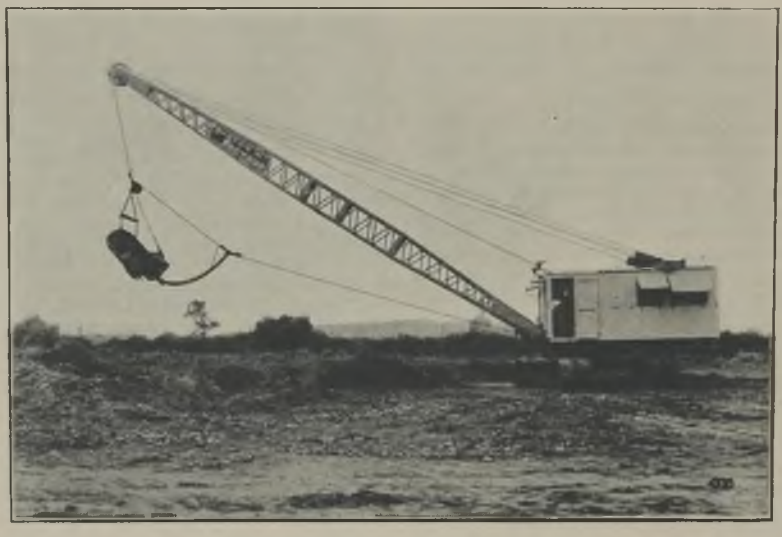
The " Meg " Earth Tester.

illustrated here. They also inform us that as usual they were represented at the Physical and Optical Societies joint exhibition, where the new instrument was shown for the first time, together with other specialities such as have been referred to from time to time in these columns.

Buck and Hickman, Ltd., of 2, Whitechapel Road, London, E. 1, have completed new editions of their general catalogue of tools and supplies for all mechanical trades and of their machine tool catalogue. The former covers 1,140 pages, and includes tools, scales, gauges, and indeed all requisites for mechanical work of any description. The machine tool catalogue, which occupies about the same number of pages, is divided into a number of sections devoted to machines of different types, e.g. drilling, planing, grinding, shearing, etc., etc. Both catalogues would be frequently referred to in the workshop or the foundry.

The disc has a central trunnion extended to form a renewable liner to the pump section compartment. The rim of the sealing drum prevents the inward circulation of liquid under pressure. The suction pump is on the shaft side of the impeller and has therefore no stuffing box under working pressure. The impeller shaft passes through a stuffing box packed only against atmospheric pressure and provision is made for the admission of clean water at low pressure through a hard metal neck bush between the suction compartment and the gland packings. The pump is made in sizes of 2, 3, 4, 5, 6, 8, 10, and 12 ins. with capacity in lb. per hour for each 10% by weight ranging from 6,400 to 230,400, the requisite approximate h.p. required for each 10 ft. lift based on the weight of pure water ranging from ¾ to 14½.

Ruston-Bucyrus, Ltd., of Lincoln, remind us that the successful completion of the great Lloyd's



Ruston-Bucyrus 52-B Dragline.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report having received the following new orders:— For England: One 3-roller Raymond mill for coal, one 3 ft. air separating plant for precipitated chalk, and one 6 ft. by 22 in. Hardinge mill for retort carbon. For France: One No. 00 Raymond pulverizer for phosphate, three 4 ft., type 37, 2-surface Hum-mer electric screens for cement slurry, one No. 00 pulverizer for unnamed duty, four 4 ft. Hum-mer electric screens for salt, and one No. 00 Raymond pulverizer for chlorate of lime. For Rhodesia: One 3 ft. by 8 in. Hardinge ball-mill for burnt lime. For Africa: One 4 ft. by 5 ft., type 39, 2-surface Hum-mer electric screen for screening diamond gravel.

Edgar Allen and Co., Ltd., of Imperial Steel Works, Sheffield, issue a booklet describing their stag centrifugal pump, which is designed for dealing with water-borne solids and is suitable for use in dredging and alluvial mining operations and in water concentration practice. The pump has been specially designed for minimum wear and is briefly described as containing an impeller shroud on the suction side, which forms a sealing drum overlapping the edge of the stationary sealing disc.

Barrage scheme, known as the Sukkur Barrage, for the river Indus in India, was largely made possible by the extensive employment of excavators of Bucyrus and Ruston-Hornsby manufacture, which it will be recalled were then operating as separate concerns. Some reference was made to this matter in our issue of June last. They also publish information about a new addition to their range of Diesel-driven excavators. This machine known as the 52-B is fully convertible and is equipped with a 6-cylinder Ruston engine of 160 b.h.p. specially built for this duty. The excavator is fitted with a bucket of 2¼ cu. yds. capacity for a 31 ft. boom or with buckets of 2 or 1½ cu. yds. capacity with greater boom length. As a dragline it is shown in the accompanying photograph.

Ruston and Hornsby, Ltd., of Lincoln, have just produced an admirable booklet devoted to the Ruston oil engine. This publication, which covers some 30 pages, is handsomely illustrated and serves a triple purpose. In the first place it directs attention to the salient features of the engine, such as its economy in fuel and its airless injection; secondly it describes the important integral parts of the mechanism; and thirdly it gives interesting notes on the routine works tests which have to be

made to ensure uniformity in the qualities of the various component parts. In addition to this, space is devoted to notes on performance from independent sources. Oil engine users, whether present or potential, should be in possession of a copy, which can be obtained from the firm. They also inform us that they have received a contract for about 100 vertical oil engines from the Russian government.

NEW DREDGE BUCKET DEVICE

Hadfields, Ltd., of Sheffield, have recently acquired the manufacturing rights of a new dredge pin locking device. This forms a means of securing the L headed coupling pin in the recess at the side of the bucket where, if the fit of the pin head is not snug, considerable wear takes place as the outcome of the rocking of the pin when the bucket turns over the tumbler.

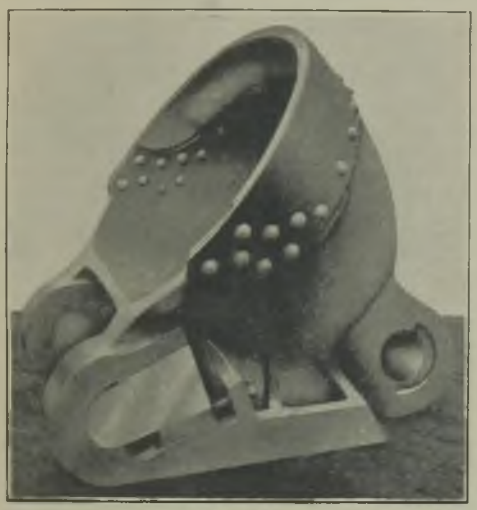


FIG. 1.

The manner in which this has been accomplished is shown in Fig. 1. which is an illustration of a complete bucket. One side of the pin head, it will be seen, is in contact with one of the walls of the pocket or recess, while the other rests on a wedge

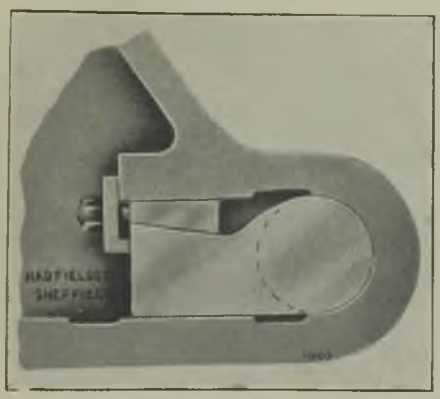


FIG. 2.

provided with a screwed shank. This shank may be screwed up tight, against a lug which forms part of the bucket casting, such that the wedge is forced against the pin head. It will be noticed also that the recess in which the pin head rests is not parallel sided and that the pin head itself is slightly tapered.

Existing pin head housings (which are parallel sided) can be adapted to this principle by means of the arrangement shown in Fig. 2, wherein it is seen that, by cutting away a part of the pin head and making one of the sides taper in relation to the other, a wedge fitted in the same way as before with a screwed shank can be introduced and, by means of a suitable bridging piece, the pin is similarly locked to the bucket.

METROPOLITAN-VICKERS PROGRESS IN 1931

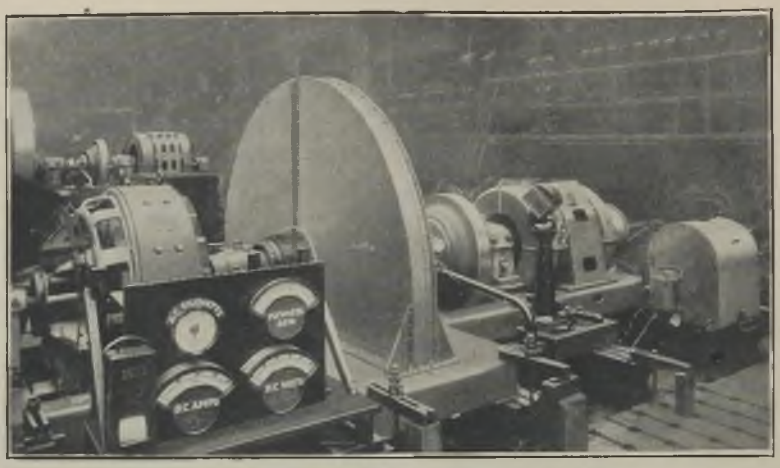
In spite of bad trading conditions during the past year the actual tonnage of the orders shipped from the works has been very nearly equal to the previous year's. Some of the largest turbo-generator sets ever sent out by the firm were shipped during 1931, and the same may be said for high voltage switchgear and transformers. Developments of great importance have taken place in the field of automatic and supervisory control, and the company's research department has been very active in all fields.

Electric Winders.—This year the ever growing list of Ward-Leonard equipments supplied by the company has received further additions. One order is for a third equipment for North Broken Hill, Ltd., New South Wales, and there are several orders from South Africa, one of which is for a motor generator equipment for a winder which comprises a 5,000 h.p. induction motor capable of exerting a pull-out torque of four times normal full load. This motor drives two d.c. generators each rated at 2,000 k.w. The speed of the set is 375 r.p.m. Orders for a large number of small a.c. motor winders have come in from abroad, one of which includes 14 such equipments.

During the year under review no less than nine large Ward-Leonard winder equipments have been through the test department. Each of these equipments was supplied with the new hydraulic slip regulator described in the MAGAZINE for February and September, 1931, which was in every case tested with its equipment under conditions as near as possible to those obtaining on the site. In the past it has been impossible to use a synchronous motor in cases where a flywheel was used for load equalization, as the power given out or taken in by the flywheel necessarily depended on a variation in speed of the motor. By the use of the slip regulator it is possible to use a synchronous motor and get the advantages of power factor control together with those of load equalization.

The illustration shows two of the synchronous motor generator flywheel equipments erected in the test department. The one in the foreground is for the Zinc Corporation, Broken Hill, New South Wales, which is running at its full synchronous speed of 800 r.p.m. The set in the background is one of three equipments ordered by North Broken Hill, Ltd. The first regulator to be installed in this country has been put into commission at Messrs. Barber Walker's Watnall Colliery.

The first installation of the new brake governor recently developed by the company was put into commission in April, 1931, and has given every



METROPOLITAN-VICKERS FLYWHEEL EQUIPMENTS.

satisfaction. At present nine similar governors are being fitted on equipments in Africa and Australia, and will shortly be in regular service. This brake system was also described in the issues of the MAGAZINE cited above.

The control gear supplied in connexion with the Broken Hill winding equipment is interesting from the point of view that, for the six Ward-Leonard sets, automatic equipments are provided, which control the sets alternatively either by a master controller on the driver's platform, or by push-buttons from various working levels below ground.

Blast-Furnace Plant.—An order for a full automatic blast-furnace equipment comprising a 130 h.p. skip hoist motor has been started. The equipment comprises automatic control and sequence of the hoist motor, small and large bell operating gear, and revolving distributor gear also the raising and lowering of the test sounding rods, each operation being sequence-controlled so as to reduce delays to a minimum and to ensure even distribution of the material in the furnace. The plant is for the Workington Iron and Steel Co.

Distributor gear has also been fitted on a Ward-Leonard hoist for Lloyds Ironstone Company at Corby, and one is being fitted to a steam driven hoist for the Stavely Company through Head Wrightson and Co.

Welding.—A new form of multiple operator generator has been tried out and proved successful. It is anticipated that this type of machine will have a considerable sale in the shipyards and other industries where it is impossible to take the machine to the job. This machine is not quite so efficient as the single operator set, but it is much superior in this respect to the type of multiple operator machine usually offered. The company has now in operation a number of automatic welding equipments for both straight seam welding and circular seam welding and the speeds obtained have been such as to enable a mass of work to be dealt with, which would have been impossible with the ordinary hand-welding methods without a very considerable increase in the number of welders employed. A further important development which has been undertaken is that of the atomic hydrogen welding equipment. Several equipments have been sold, and the company anticipate that this will be a very successful development.

A NEW HIGH-SPEED DIESEL

A new development in Diesel engine practice has been in the direction of increasing speeds, and there have been for some time on the market various high-speed Diesel engines operating on the four-cycle principle. **Petters, Ltd.,** of Yeovil, who are well-known as makers of a slow running Diesel engine operating on the two-cycle principle have now developed an engine capable of running at a speed of over 1,000 r.p.m. which is also valveless. Scavenge pumps of the positive piston type are used for each cylinder and the lubricating oil consumption is comparable with that of the four-stroke type. With three cylinders, as shown in the accompanying illustration (Fig. 1), the engine develops 36 b.hp. at 1,200 r.p.m., with a maximum speed of 1,600 r.p.m.

The scavenge pumps are chain driven at engine speed and deliver air through ports in the wall of each cylinder. Each cylinder discharges exhaust into a common manifold of neat design. The fuel pumps and atomizers are of Bosch manufacture, and work at a comparatively low pressure. A chain drive is arranged for the fuel and water pumps together with the dynamo. A governor is coupled to the fuel pump shaft to cut out the fuel pumps when the engine reaches its maximum speed; it controls the fuel delivery at the cruising speeds, and

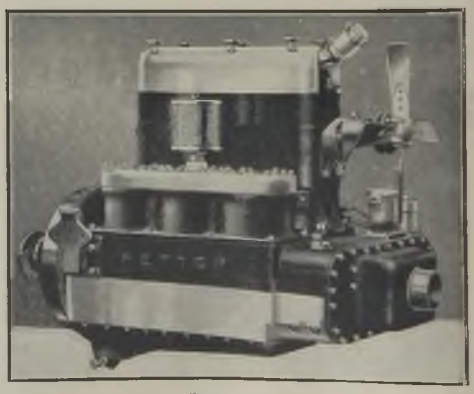


FIG. 1.

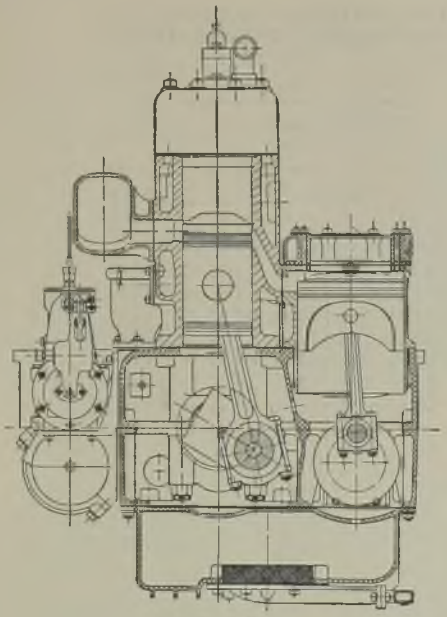


FIG. 2.

in addition provides for slow-speed running at about 300 r.p.m. A starter motor is provided with its piston engaging a gear ring on the flywheel and an accessible fuel-oil filter is arranged. A section through the engine is given in Fig. 2 which explains the principal features of its operation.

METAL MARKETS

COPPER.—The middle of January saw rather firmer markets, due to an attempt to advance prices on the part of Copper Exporters Inc. Electrolytic in New York consequently advanced from 7·25 cents to 7·37½ cents per lb. f.a.s. and Standard hardened in sympathy, but consumers refused to follow the movement and at the close of the month Standard quotations reflected a slight loss on balance, whilst although Exporters did not officially reduce their quotation for electrolytic again, "outside" metal was offering at around 7 cents f.a.s. The new sales conditions proposed by Copper Exporters have aroused stiff opposition from the German members.

Average price of Cash Standard Copper : January, 1932, £39 10s. 1d. ; December, 1931, £38 6s. 5d. ; January, 1931, £44 19s. 7d. ; December, 1930, £46 16s. 4d.

TIN.—Tin prices reflected a moderate fall during January, partly because of the advance which occurred in sterling exchange, but partly also because of the generally unsatisfactory industrial, commercial, and political situation. America showed very little interest on the whole and until that big consumer is able to buy on a good scale it is difficult to see how values can display much strength. The long-awaited improvement in the statistical position, following the patient efforts of the Tin Producers Association to adjust output to consumption has not yet materialized. The Tin Pool has now acquired 21,000 tons, which will not commence to be marketed until the price is £165.

Average price of Cash Standard Tin : January, 1932, £140 5s. 6d. ; December, 1931, £138 19s. 7d. ; January, 1931, £115 17s. 7d. ; December, 1930, £111 12s. 4d.

LEAD.—Prices tended rather easier during January, at least in London, despite considerable support by the producing group. Trade demand was poor and world stocks remain at a very high figure, probably in excess of 300,000 tons. It remains to be seen whether producers are still satisfied with the situation or whether they will decide in the near future to take further curtailment-measures if trade does not revive. In America the price was steady during the month at 3·75 cents.

Average mean price of soft foreign lead : January, 1932, £15 2s. 1d. ; December, 1931, £15 5s. 5d. ; January, 1931, £13 17s. 9d. ; December, 1930, £15 5s. 8d.

SPELTER.—Despite occasional spurts, the undertone of the spelter market last month was not particularly firm, which was not surprising in view of the continued dull industrial demand, made worse by the troubles in India and China. Sentiment was not cheered by the revelation that the Cartel's stocks have recently tended to expand despite the additional "cut" in output now enforced. In America the spelter position is very bad, large stocks having accumulated, and the quotation has fallen to the record low level of 2·90 cents per lb.

Average mean price of spelter : January, 1932, £14 12s. 6d. ; December, 1931, £14 11s. 9d. ; January, 1931, £12 18s. 7d. ; December, 1930, £13 19s. 9d.

IRON AND STEEL.—Sentiment remained cheerful on the British pig-iron market during January, but business did not expand much further, and there is little hope of any immediate widespread trade revival entailing the blowing-in of idle furnaces on a big scale. Cleveland prices remained unaltered with No. 3 foundry G.M.B. at 58s. 6d. minimum. Hematite was scarcely firm and sellers of East Coast Mixed Numbers accepted less than 64s. 6d. per ton. The British steel trade remained dull throughout January, but many steelmasters are hoping that they may soon receive some measure of tariff protection. The market for Continental steel remained depressed, despite signs of an incipient revival in demand in certain markets, and competition between makers was very keen.

IRON ORE.—Business during the past month has remained on a very poor scale. Ironmasters throughout Europe seem more than adequately covered by existing contracts and in Germany fresh arrangements have been made for the postponement of deliveries. Prices are nominally unaltered on the basis of about 16s. 6d. per ton c.i.f. for best Bilbao rubio.

ANTIMONY.—At the close of January, English regulus was quoted at £40 to £42 10s. per ton. Sales of Chinese regulus were slow owing to the fighting in China, but spot was offered at about £27 15s. ex warehouse.

ARSENIC.—Only a limited quantity of Cornish white is offering at £23 5s. to £23 10s. per ton f.o.r. mines and Mexican remains nominal owing to exchange variations.

BISMUTH.—A further reduction in the price of this metal was made in January, the official quotation now standing at 4s. 10d. per lb. for 5 cwt. lots and over. Demand is only moderate.

LONDON DAILY METAL PRICES.

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

	COPPER.									TIN.						ZINC (Spelter).			LEAD.						SILVER.		GOLD.	
	STANDARD.						ELECTRO-LYTIC.			BEST SELECTED.									SOFT FOREIGN.			ENGLISH.			Cash.		Forward.	
	Cash.			3 Months.																								
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	d.		d.		s.	d.
Jan.																												
12	42	16	3	42	11	3	49	10	0	44	0	0	142	13	9	145	16	3	14	13	9	15	12	6	17	0	0	19 15/16	20		121	4
13	42	3	9	41	18	9	49	5	0		—		142	3	9	145	3	9	14	11	3	15	10	0	17	0	0	19 15/16	19 15/16		120	9
14	41	5	7½	41	5	7½	48	0	0		—		141	1	3	144	6	3	14	11	3	15	6	3	16	15	0	19 15/16	20		120	4
15	40	15	7½	40	15	7½	48	0	0	42	10	0	141	16	3	144	18	9	14	13	9	15	6	3	16	15	0	19 7/8	19 7/8		117	11
18	39	15	7½	39	15	7½	47	10	0		—		140	11	3	143	13	9	14	8	9	15	3	9	16	10	0	19 13/16	19 13/16		118	8
19	39	6	3	39	8	9	47	0	0	41	10	0	140	16	3	143	16	3	14	5	0	14	18	9	16	5	0	19 7/8	19 7/8		120	0
20	39	16	3	39	16	3	47	0	0		—		141	11	3	144	11	3	14	10	0	15	1	3	16	10	0	19 13/16	19 7/8		120	0
21	39	8	9	39	10	0	46	10	0		—		141	7	6	144	8	9	14	8	9	14	16	3	16	5	0	19 7/8	19 7/8		119	5
22	38	14	4½	38	18	9	46	0	0	41	0	0	140	3	9	143	3	9	14	6	3	14	16	3	16	5	0	19 15/16	19 15/16		119	8
25	38	16	3	39	1	3	46	0	0		—		138	16	3	141	16	3	14	6	3	14	17	6	16	5	0	19 7/8	19 15/16		120	9
26	39	0	7½	39	3	1½	46	0	0	41	5	0	140	6	3	143	6	3	14	8	9	14	18	9	16	5	0	19 7/8	19 7/8		119	3
27	38	15	7½	38	18	1½	46	0	0		—		139	16	3	142	13	9	14	6	3	14	16	3	16	5	0	19 15/16	19 7/8		119	9
28	38	0	7½	38	3	1½	45	15	0		—		138	8	9	141	6	3	14	2	6	14	10	0	16	0	0	19 7/8	19 15/16		119	3
29	37	6	3	37	8	1½	45	5	0	39	10	0	137	16	3	140	11	3	13	16	3	14	7	6	16	0	0	19 15/16	19 7/8		119	7
Feb.																												
1	37	13	1½	37	13	9	45	10	0		—		139	16	3	142	8	9	14	0	0	14	10	0	16	0	0	20	20 1/16		120	2
2	38	4	4½	38	1	10½	44	0	0	40	10	0	140	18	9	143	11	3	14	3	9	14	12	6	16	0	0	19 15/16	19 15/16		119	7
3	37	18	9	37	11	3	44	0	0		—		138	15	0	141	6	3	13	17	6	14	7	6	16	0	0	19 15/16	19 15/16		119	5
4	37	13	1½	37	11	10½	44	0	0		—		139	3	9	142	2	6	13	16	3	14	8	9	16	0	0	19 15/16	19 15/16		120	1
5	37	17	6	37	13	9	43	10	0	40	10	0	139	12	6	142	7	6	13	17	6	15	0	0	16	5	0	19 15/16	19 15/16		119	9
8	36	7	6	36	3	9	42	10	0		—		138	7	6	141	5	0	13	17	6	14	10	0	16	0	0	19 15/16	19 15/16		120	1
9	36	6	10½	36	4	4½	42	10	0	40	0	0	138	7	6	141	2	6	13	17	6	14	10	0	16	0	0	19 15/16	19 15/16		119	11
10	36	16	3	35	6	3	40	10	0		—		137	2	6	140	0	0	13	15	0	14	11	3	16	0	0	19 15/16	19 17/16		120	4

CADMIUM.—About 2s. 4d. to 2s. 5d. per lb., according to quantity, is named, demand being rather quiet, but fairly steady.

COBALT METAL.—Leading interests continue to quote officially 3·65 dollars per kilo, but rebates are granted for substantial contracts.

COBALT OXIDES.—Only a moderate demand is in evidence and stocks in this country continue large. Prices stand at around 5s. 3d. to 5s. 4d. per lb. for black and 6s. to 6s. 1d. for grey.

CHROMIUM METAL.—There is nothing fresh to report, fair quantities still changing hands at about 3s. per lb.

TANTALUM.—Rather more activity has been seen in this metal recently, prices being about £25 to £30 per lb.

PLATINUM.—There has not been much demand from consumers recently, but prices have varied only according to exchange movements, the current value being about £10 18s. to £11 4s. per oz. for refined metal.

PALLADIUM.—About £5 5s. to £5 15s. per oz. is named, but business is slow.

IRIDIUM.—With only occasional interest on the part of buyers, quotations are rather nominal at about £24 to £25 per oz. for sponge and powder.

OSMIUM.—Quotations are practically unchanged at £20 to £21 per oz.

TELLURIUM.—There is absolutely nothing moving and quotations are quite nominal.

SELENIUM.—Sellers here are only quoting against definite inquiries, but about 7s. 8d. to 7s. 9d. per lb. on a gold basis is approximately the present value.

MANGANESE ORE.—The continued depression in the steel industry has prevented any revival in the demand for manganese ore, but prices are quotably unchanged at 10d. to 10¼d. per unit c.i.f. for best Indian, and 9d. to 9½d. c.i.f. for good 48% Indian and washed Caucasian ores.

ALUMINIUM.—In this country a quietly steady demand continues at the unaltered quotation of £95 less 2% delivered for ingots and bars, but as from January 1 the international quotation of the European Cartel has been reduced to £80 (gold) per metric ton, delivered to any part of the world.

SULPHATE OF COPPER.—Current quotations for English material stand at £19 10s. to £20 per ton, less 5%.

NICKEL.—Quotations continue to move in accordance with the fluctuations in the value of the £ sterling, the present price being £240 to £245 according to quantity.

CHROME ORE.—Although demand is only on a limited scale compared with a year or so ago, prices are well maintained, good 48% Rhodesian ore being held for about 82s. 6d. per ton c.i.f., and New Caledonian at 105s. to 110s. c.i.f. for 55 to 57%.

QUICKSILVER.—Demand generally has been poor, and prices are easier. The selling organization of the Italo-Spanish combine now has its headquarters in London, where spot material is obtainable at about £17 15s. per bottle, net.

TUNGSTEN ORE.—Interest on the part of buyers has remained negligible and in the absence of sales prices show little change at 14s. 6d. to 15s. per unit c.i.f. The situation in China is likely to hinder offers from that quarter, but until business improves the market is not likely to be affected seriously.

MOLYBDENUM ORE.—A quiet business is passing at between 37s. 6d. and 39s. per unit c.i.f. for 80 to 85% concentrates.

GRAPHITE.—Very little inquiry is forthcoming, and prices are rather nominal at about £16 to £18 per ton c.i.f. for good 85 to 90% raw Madagascar flake, and £17 to £19 c.i.f. for 90% Ceylon lumps.

SILVER.—The predominant feature of the silver market during January was quietness. On January 1 spot bars closed at 20 3/16d. and with only a little Continental demand and some moderate American offerings prices declined to 19⅝d. for spot bars on January 15. Further easiness developed in the second half of the month, China and India taking little interest owing to disturbed local conditions. By January 28 spot bars had fallen to 19 1/16d., but recovered to 19 3/16d. on the last day of the month. February opened with a better tone.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
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
June	855,073	42,677	897,750
July	872,198	44,645	916,843
August	870,822	45,603	916,425
September	872,053	43,971	916,024
October	900,353	44,760	945,113
November	855,102	45,408	900,510
December	877,178	46,175	923,353
January, 1932	890,688	46,096	936,784

TRANSVAAL GOLD OUTPUTS.

	December.		January.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	90,000	£146,189	98,000	£153,941
City Deep	78,000	21,157	79,000	20,999
Cons. Main Reef	66,700	22,928	70,800	23,954
Crown Mines	271,000	84,029	274,000	83,287
Daggafontein	—	—	21,000	£13,556
D'rb'n Roodepoort Deep	48,200	16,057	49,700	15,313
East Geduld	51,000	15,152	52,000	15,476
East Rand P.M.	158,000	41,397	161,000	42,294
Geduld	84,200	26,899	85,500	27,150
Geldenhuis Deep	73,800	17,299	74,500	16,993
Glynn's Lydenburg	6,300	2,641	6,600	2,572
Government G.M. Areas	230,000	£401,540	204,000	£403,290
Kleinfontein	52,000	10,550	53,400	10,314
Langlaagte Estate	79,000	£111,295	80,000	£111,664
Luipaard's Vlei	31,500	8,009	33,200	8,351
Meyer and Charlton	16,200	£16,627	18,400	£17,284
Modderfontein New	168,000	65,458	169,000	65,923
Modderfontein B	74,000	21,388	76,500	21,584
Modderfontein Deep	44,700	22,060	44,800	22,091
Modderfontein East	73,500	21,439	73,500	21,502
New State Areas	78,000	£166,111	80,000	£170,683
Nourse	68,500	20,611	71,000	21,006
Randfontein	240,000	£282,411	248,000	£280,569
Robinson Deep	96,300	28,374	98,300	£119,481
Rose Deep	59,100	12,470	61,400	12,898
Simmer and Jack	78,600	21,083	82,100	£92,717
Springs	68,300	£145,255	68,500	£149,845
Sub Nigel	36,700	31,544	36,700	£133,722
Transvaal G.M. Estates	16,600	5,150	16,600	5,187
Van Ryn	47,000	£44,411	47,500	£44,679
Van Ryn Deep	64,000	£94,180	65,000	£94,162
West Rand Consolidated	94,500	£105,311	94,500	£105,725
West Springs	74,500	£75,129	75,000	£75,935
Witw'tersr'nd (Knights)	63,000	£55,093	67,000	£56,465
Witwatersrand Deep	39,700	11,570	44,000	13,183

Values in S.A. currency.

COST AND PROFIT ON THE RAND, Etc.

Compiled from official statistics published by the Transvaal Chamber of Mines.

	Tons milled.	Yield per ton.	Work'g cost per ton.	Work'g profit per ton.	Total working profit.
		s. d.	s. d.	s. d.	£
October, 1930	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	2,592,800	28 7	20 1	8 6	1,105,711
May	2,751,400	27 10	19 6	8 4	1,149,105
June	2,698,100	28 0	19 7	8 5	1,140,399
July	2,771,400	27 10	19 6	8 4	1,155,466
August	2,799,800	27 10	19 5	8 5	1,159,382
September	2,765,400	27 10	19 5	8 5	1,162,355
October	2,870,800	27 8	19 3	8 5	1,210,743
November	2,726,720	27 10	19 5	8 5	1,144,208
December	—	—	—	—	1,173,732

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
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
June 30	207,209	13,286	3,345	223,840
July 31	208,155	13,512	1,817	223,484
August 31	209,409	13,563	1,705	224,677
September 30	209,424	13,276	1,626	224,326
October 31	208,987	13,061	1,517	223,565
November 30	209,270	12,882	1,429	223,581
December 31	211,552	12,260	1,402	225,214
January 31, 1932	215,752	12,394	1,598	229,744

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	43,731
June	51,762	48,406	45,208	44,118
July	48,960	46,369	45,810	44,765
August	50,611	46,473	46,152	43,292
September	47,716	45,025	46,151	42,846
October	43,056	46,923	45,006	44,260
November	47,705	46,219	44,351	44,516
December	44,772	46,829	46,485	50,034

RHODESIAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	24,800	11,815	24,800	9,932
Globe and Phœnix	6,008	6,193	6,060	6,047
Lonely Reef	7,500	2,686	7,700	2,402
Luiri Gold	1,256	730	—	—
Rezende	6,400	3,602	6,500	2,608
Sherwood Star	4,800	£9,034	4,800	£9,168
Wanderer Consolidated	14,900	3,176	15,200	3,589

WEST AFRICAN GOLD OUTPUTS.

	December.		January.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	5,820	£10,806	5,745	£10,455
Ashanti Goldfields	13,020	14,615	13,063	14,596
Taquah and Abosso	10,535	£14,287	10,547	£14,403

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
January, 1931	27,306	—	405
February	38,370	4,458*	458
March	34,946	4,482	898
April	38,891	3,250	732
May	38,255	4,196	784
June	47,507	3,194	893
July	38,785	3,641	1,220
August	52,501	3,020	610
September	38,173	—	638
October	52,741	—	1,031
November	53,869	—	1,428
December	49,215	—	—
January, 1932	—	—	—

* Jan. and Feb.

AUSTRALASIAN GOLD OUTPUTS.

	December.		January.	
	Tons	Value £	Tons.	Value £
Associated G.M. (W.A.)	5,068	5,973	5,067	5,297
Blackwater (N.Z.)	3,292	6,250	2,000	6,132
Boulder Persev'ce (W.A.)	7,079	17,087	7,237	15,006
Grt. Boulder Pro. (W.A.)	6,827	18,537	—	—
Lake View & Star (W.A.)	17,143	26,258	—	—
Sons of Gwalia (W.A.)	12,410	13,738	13,048	15,260
South Kalgurli (W.A.)	9,026	16,537	9,643	15,145
Waihi (N.Z.)	25,041	8,781* / 16,360†	—	— / —
Wiluna	24,059	29,004	27,020	34,015

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA.

	December.		January.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,600	2,110	3,250	1,700
Champion Reef	8,400	5,401	8,650	5,406
Mysore	17,338	7,652	17,074	7,155
Nundydroog	12,045	7,371	12,350	7,205
Ooregum	12,511	5,494	11,150	4,369

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	December.		January.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	10,040	16,822	10,320	18,800
Frontino Gold (C'lbia)	3,810	17,514	3,260	19,419
Fresnillo	—	—	—	—
New Goldfields of Venezuela	7,061	2,257*	—	—
Oriental Cons. (Korea)	16,374	90,372*d*	16,911	87,808*d*
Remance	3,300	2,374	4,004	4,300
St. John del Rey (Brazil)	—	29,000	—	34,500
Santa Gertrudis (Mexico)	27,577	50,934*d*	25,463	32,261*d*
Viborita	—	—	—	1,780‡
West Mexican Mines	1,608	27,000*d*	—	—

d Dollars. * Oz. gold. ‡ To Jan. 16

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

July, 1931	4,757	January, 1932	3,014
August	5,375	February	—
September	2,449	March	—
October	3,282	April	—
November	2,488	May	—
December	3,222	June	—

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	November.	December.	January.
Ayer Hitam	—	113	29⅜
Batu Caves	—	40	—
Changkat	—	45	90
Gopeng	23	60	32
Hongkong Tin	—	77½	48⅜
Idris Hydraulic	1⅜	41½	6⅜
Ipoh	51½	28⅜	36
Kampar Malaya	—	—	—
Kampong Lanjut	48	50	50
Kamunting	128	99	70
Kent (F.M.S.)	—	34	15
Kinta	13	22½	20
Kinta Kellas	17¾	23⅜	26¾
Kramat Tin	75	70	85
Kuala Kampar	40	28	40
Kundang	—	—	—
Lahat	10½	13½	14½
Lower Perak	92	119	85
Malaya Consolidated	—	—	—
Malayan Tin	86½	77¼	89½
Malim Nawar	26	22	25
Pahang	125	125	125
Penawat	—	—	—
Pengkalen	—	75	14
Petaling	106	68	155
Rahman	40⅝	40	40⅜
Rambutan	—	12	4⅛
Rantau	3¾	25	11⅜
Rawang	45	40	30
Rawang Concessions	29	35	37
Renong	31½	25⅛	22⅛
Selayang	—	—	17⅛
Southern Malayan	84½	137	113
Southern Perak	30⅜	26¾	53½
Southern Tronoh	34	31	24
Sungei Besi	33	33	33
Sungei Kinta	—	15½	22½
Sungei Way	20½	77½	68⅜
Taiping	13	18¼	17
Tanjong	—	13¾	12
Teja Malaya	—	—	—
Tekka	9	30	27
Tekka-Taiping	—	45	40½
Temengor	—	—	—
Temoh	—	—	—
Tronoh	57	25	52
Ulu Klang	—	18½	—

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	November.	December.	January.
Anglo-Nigerian	48½	69¾	53⅜
Associated Tin Mines	157	255	230
Baba River	4½	6	7⅞
Batura Monguna	3	3	1½
Bisichi	30	30	—
Daffo	4	5	—
Ex-Lands	38	49	56
Filani	—	6	3
Jantar	12	12	10
Jos	12	11	—
Juga Valley	8½	6	5⅞
Kaduna Syndicate	25	30	25
Kaduna Prospectors	12	11	11
Kassa	11½	15½	15
London Tin	120	160	150
Lower Bisichi	4¼	3¾	—
Naraguta Extended	—	—	—
Nigerian Consolidated	10	10½	12
Offin River	2¾	2⅞	3½
Ribon Valley	10	16⅜	12
Tin Fields	5	5¼	—
United Tin Areas	14⅜	25	22½
Yarde Kerri	4	4	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	November.	December.	January.
Anglo-Burma (Burma)	36½	—	28
Aramayo Mines (Bolivia)	161	127	130
Bangrin (Siam)	76½	—	—
Beralt	30*	30*	30*
Consolidated Tin Mines (Burma)	100	95	95
East Pool (Cornwall)	46	49½	49
Fabulosa (Bolivia)	57½	40†	—
Kagera (Uganda)	20	25	—
Kamra	—	—	—
Malaysiam Tin	9	8½	8½
Mawchi	209*	203½*	—
Patino	1,056	1,056	—
Pattani	—	—	—
San Finx (Spain)	22½*	—	—
Siamese Tin (Siam)	119	46½	25½
South Crofty	—	51½	49
Tavoy Tin (Burma)	56	61	55
Tongkah Harbour (Siam)	25	48	40
Toyo (Japan)	73	73	60¾
Zaaiplaats	16¾	16½	—

* Tin and Wolfram. † Tons fine tin.

COPPER, LEAD, AND ZINC OUTPUTS.

		Dec.	Jan.
Britannia Lead	Tons refined lead	2,564	—
	Oz. refined silver	98,029	—
Broken Hill South	Tons lead conc.	4,584	7,181
	Tons zinc conc.	4,844	7,506
Burma Corporation	Tons refined lead	5,880	5,880
	Oz. refined silver	470,000	490,000
Electrolytic Zinc	Tons zinc	—	—
Indian Copper	Tons copper	214	350
Messina	Tons copper	804	775
Mount Isa	Tons lead bullion	3,457	—
Mount Lyell	Tons concentrates	3,069	3,429
North Broken Hill	Tons lead conc.	5,220	4,330
	Tons zinc conc.	5,220	4,047
Rhodesia Broken Hill	Tons V_2O_5	30	35
	Tons V_2O_5 conc.	75	100
Roan Antelope	Tons concentrates	295	—
	Tons blister copper	4,164	2,457
San Francisco Mexico	Tons lead conc.	3,993	—
	Tons zinc conc.	—	—
Tetiuhe	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Trepca	Tons lead conc.	4,584	3,915
	Tons zinc conc.	4,312	3,776
Zinc Corporation	Tons lead conc.	5,793	—
	Tons zinc conc.	4,616	—

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

	November.	December.
Iron Ore ..... Tons ..	138,971	235,032
Manganese Ore ..... Tons ..	4,514	2,928
Iron and Steel ..... Tons ..	379,363	266,901
Copper and Iron Pyrites ..... Tons ..	27,857	39,546
Copper Ore, Matte, and Prec. ... Tons ..	3,904	3,476
Copper Metal ..... Tons ..	11,537	9,994
Tin Concentrate ..... Tons ..	3,878	5,236
Tin Metal ..... Tons ..	875	2,164
Lead Pig and Sheet ..... Tons ..	30,487	32,348
Zinc (Spelter) ..... Tons ..	10,203	10,005
Zinc Sheets, etc. ..... Tons ..	3,550	2,233
Aluminium ..... Tons ..	1,914	883
Mercury ..... Lb....	114,308	172,606
Zinc Oxide ..... Tons ..	950	314
White Lead ..... Cwt....	22,124	10,329
Red and Orange Lead ..... Cwt....	7,243	5,270
Barytes, ground ..... Cwt....	53,280	39,313
Asbestos ..... Tons ..	2,948	1,842
Boron Minerals ..... Tons ..	115	726
Borax ..... Cwt....	12,185	39,873
Basic Slag ..... Tons ..	5,357	6,697
Superphosphates ..... Tons ..	8,998	5,914
Phosphate of Lime ..... Tons ..	27,827	18,888
Mica ..... Tons ..	146	151
Sulphur ..... Tons ..	3,425	8,256
Nitrate of Soda ..... Cwt....	550,865	97,475
Potash Salts ..... Cwt....	268,411	180,228
Petroleum : Crude ..... Gallons	12,739,899	14,562,159
Lamp Oil ..... Gallons	20,921,647	28,032,400
Motor Spirit ..... Gallons	61,563,771	72,312,499
Lubricating Oil .... Gallons	7,242,942	7,162,500
Gas Oil ..... Gallons	3,929,802	10,125,638
Fuel Oil ..... Gallons	42,538,270	32,296,597
Asphalt and Bitumen ..... Tons ..	7,793	10,613
Paraffin Wax ..... Cwt....	150,162	152,711
Turpentine ..... Cwt....	32,870	35,382

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	November.	December.	January.
Anglo-Ecuadorian	15,499	18,014	18,038
Apex Trinidad	40,600	43,380	44,310
Attock	1,892	1,809	1,611
British Burmah	4,224	4,350	4,416
British Controlled	37,022	39,738	39,970
Kern Mex	920	934	984
Kern River (Cal.)	2,922	2,554	2,436
Kern Romana	807	670	564
Kern Trinidad	5,523	4,792	4,968
Lobitos	25,420	25,746	25,327
Phœnix	38,594	45,707	46,884
St. Helen's Petroleum	5,147	5,053	5,089
Steaua Romana	82,267	87,054	—
Tampico	2,549	2,563	2,678
Tocuyo	1,619	1,730	1,784
Trinidad Leaseholds	13,050	13,650	21,300

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted

	Jan. 11, 1932.			Feb. 10, 1932.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		5	6		5	9
Anglo-Egyptian B.	1	0	0	1	3	9
Anglo-Persian 1st Pref.	1	3	0	1	3	3
,, ,, Ord.	1	11	9	1	16	3
Apex Trinidad (5s.)		10	3		10	6
Attock		13	9		11	3
British Burmah (8s.)		3	6		4	0
British Controlled ($5)		1	3		1	6
Burmah Oil	1	15	0	1	16	9
Kern River Cal. (10s.)		1	9		2	0
Lobitos, Peru		17	6	1	2	6
Mexican Eagle, Ord. (4 pesos)		6	3		7	0
,, ,, 8% Pref. (4 pesos)		6	6		6	9
Phœnix, Roumanian		3	9		4	0
Royal Dutch (100 fl.)	13	10	0	15	5	0
Shell Transport, Ord.	1	16	3	1	19	3
,, ,, 5% Pref. (£10)	8	15	0	9	0	0
Steaua Romana		3	9		4	3
Trinidad Leaseholds	1	4	6	1	5	0
United British of Trinidad (6s. 8d.)		3	0		3	0
V.O.C. Holding		17	6	1	0	9

PRICES OF CHEMICALS. February 9.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		19	9
,, 80%	,,	1	17	3
,, Glacial	per ton	59	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.		1	0
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	7	2	0
Antimony, Tartar Emetic, 43/44%	per lb.			10
,, Sulphide, golden	,,			9
Arsenic, White (foreign)	per ton	24	10	0
Barium, Carbonate (native), 94%	,,	4	10	0
,, Chloride	,,	11	0	0
Barytes	,,	7	15	0
Benzol, standard motor	per gal.		1	4
Bleaching Powder, 35% Cl.	per ton	8	15	0
Borax	,,	16	10	0
Boric Acid	,,	26	10	0
Calcium Chloride, solid, 70/75%	,,	5	10	0
Carbolic Acid, crude 60's	per gal.		1	9
,, ,, crystallized, 40°	per lb.			5½
Carbon Disulphide	per ton	30	0	0
Citric Acid	per lb.		1	1½
Copper Sulphate	per ton	17	15	0
Creosote Oil (f.o.b. in Bulk)	per gal.			5½
Cresylic Acid, 98-100%	,,		1	6
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per lb.	1	7	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	0	0
Lead, Acetate, white	,,	39	0	0
,, Nitrate (ton lots)	,,	28	10	0
,, Oxide, Litharge	,,	31	0	0
,, White	,,	40	10	0
Lime, Acetate, brown	,,	8	0	0
,, ,, grey, 80%	,,	12	0	0
Magnesite, Calcined	,,	8	5	0
Magnesium Chloride	,,	5	10	0
,, Sulphate, comml.	,,	4	10	0
Methylated Spirit Industrial 61 O.P.	per gal.		2	0
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	2	10	0
Phosphoric Acid. (Conc. 1 750)	per lb.			10
Pine Oil	per cwt.	2	5	0
Potassium Bichromate	per lb.			5
,, Carbonate, 96/98%	per ton	29	10	0
,, Chlorate	,,	34	0	0
,, Chloride 80%	,,	11	5	0
,, Ethyl Xanthate	per 100 kilos	7	10	0
,, Hydrate (Caustic) 88/90%	per ton	37	10	0
,, Nitrate	,,	25	10	0
,, Permanganate	per lb.			8½
,, Prussiate, Yellow	,,			8½
,, ,, Red	,,		2	0
,, Sulphate, 90%	per ton	12	10	0
Sodium Acetate	,,	21	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			4
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	29	0	0
,, Cyanide 100% NaCN basis	per lb			8
,, Ethyl Xanthate	per 100 kilos	7	4	0
,, Hydrate, 76%	per ton	14	0	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	8	16	0
,, Phosphate, comml.	,,	13	0	0
,, Prussiate	per lb.			5½
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	2	15	0
,, ,, (Salt-Cake)	,,	3	0	0
,, Sulphide Conc., 60/65%	,,	10	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	12	0	0
,, Roll	,,	12	10	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.		1	1½
Turpentine	per ton	54	0	0
Tin Crystals	per lb.			10½
Titanous Chloride	,,			10¾
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	10	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Jan. 11, 1932. £ s. d.	Feb. 10, 1932. £ s. d.
SOUTH AFRICA:		
Brakpan	3 6 6	3 5 0
City Deep	5 6	6 0
Consolidated Main Reef	1 4 0	1 2 0
Crown Mines (10s.)	5 2 6	5 1 3
Daggafontein	2 17 6	2 13 9
Durban Roodepoort Deep (10s.)	19 0	17 9
East Geduld	3 5 6	3 0 0
East Rand Proprietary (10s.)	14 3	13 9
Geduld	4 10 0	4 0 0
Geldhenhuis Deep	11 3	10 3
Glynn's Lydenburg	5 0	5 0
Government Gold Mining Areas (5s.)	1 13 0	1 12 6
Grootvlei	1 6 3	1 2 6
Langlaagte Estate	1 6 0	1 4 9
Meyer & Charlton	1 2 0	1 1 0
Modderfontein New (10s.)	2 10 0	2 7 6
Modderfontein B (5s.)	12 6	11 6
Modderfontein Deep (5s.)	1 0 0	18 0
Modderfontein East	1 15 0	1 13 9
New State Areas	2 11 6	2 10 0
Nourse	17 3	15 9
Randfontein	1 8 0	1 7 3
Robinson Deep A (1s.)	15 0	15 0
" " B (7s. 6d.)	10 3	10 0
Rose Deep	6 6	6 6
Simmer & Jack (2s. 6d.)	4 0	3 4
Springs	3 12 0	3 7 0
Sub Nigel (10s.)	3 14 6	3 15 0
Van Ryn	11 0	10 6
Van Ryn Deep	1 2 6	1 1 0
Village Deep (9s. 6d.)	2 6	2 3
West Rand Consolidated (10s.)	11 6	11 6
West Springs	13 9	12 3
Witwatersrand (Knight's)	10 6	9 0
Witwatersrand Deep	4 3	5 0
RHODESIA:		
Cam and Motor	1 7 6	1 6 3
Gaika	3 6	3 6
Globe and Phœnix (5s.)	14 9	15 0
Lonely Reef	16 3	16 3
Mayfair	4 6	4 6
Rezende	1 1 0	1 5 0
Shamva	1 0	1 0
Sherwood Starr (5s.)	12 6	11 3
GOLD COAST:		
Ashanti (4s.)	2 1 6	1 15 3
Taquah and Abosso (5s.)	6 0	4 6
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	3 0	3 3
Great Boulder Propriet'y (2s.), W.A.	2 0	1 9
Lake View and Star (4s.), W.A.	8 3	8 3
Sons of Gwalia, W.A.	4 6	4 9
South Kalgurli (10s.), W.A.	12 0	13 6
Waihi (5s.), N.Z.	14 0	15 0
Wiluna Gold, W.A.	8 0	10 0
INDIA:		
Balaghat (10s.)	1 6	2 0
Champion Reef (10s.)	9 3	9 3
Mysore (10s.)	7 0	8 6
Nundydroog (10s.)	17 0	19 6
Ooregum (10s.)	3 9	2 6
AMERICA:		
Camp Bird (2s.), Colorado	3	6
Exploration (10s.)	2 3	2 0
Frontino and Bolivia, Colombia	16 3	16 3
Mexican Corporation, Mexico (10s.)	3 6	3 6
Mexico Mines of El Oro, Mexico	1 6	1 6
Panama Corporation	10 0	6 3
St. John del Rey, Brazil	18 6	18 6
Santa Gertrudis, Mexico	6 9	6 6
Selukwe (2s. 6d.), British Columbia	2 0	2 0
MISCELLANEOUS:		
Chosen, Korea	5 0	3 9
Lena Goldfields, Russia	6	6

COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	3 0	2 6
Esperanza Copper	13 9	13 9
Indian (2s.)	1 0	1 0
Loangwa (5s.), Rhodesia	1 9	1 6
Luiri (5s.), Rhodesia	4 0	2 6
Messina (5s.), Transvaal	6 6	6 6
Mount Lyell, Tasmania	18 0	17 0
Namaqua (£2), Cape Province	4 0	3 9
Rhodesia-Katanga	11 3	11 3
Rio Tinto (£5), Spain	13 5 0	14 10 0
Roan Antelope (5s.), Rhodesia	8 3	7 3
Tanganyika Con.	17 6	18 6
Tharsis (£2), Spain	2 10 0	2 13 6

LEAD-ZINC:	Jan. 11, 1932. £ s. d.	Feb. 10, 1932. £ s. d.
Amalgamated Zinc (8s.), N.S.W.	6 3	6 3
Broken Hill Proprietary, N.S.W.	13 3	12 0
Broken Hill, North, N.S.W.	2 11 3	2 13 9
Broken Hill South, N.S.W.	1 16 3	1 13 9
Burma Corporation (10 rupees)	8 6	8 6
Electrolytic Zinc Pref., Tasmania	17 6	17 6
Mount Isa, Queensland	10 0	10 0
Rhodesia Broken Hill (5s.)	1 0	1 0
San Francisco (10s.), Mexico	8 0	7 6
Sulphide Corporation (15s.), N.S.W.	9 0	8 6
ditto, Pref.	10 6	10 6
Zinc Corporation (10s.), N.S.W.	1 3 9	1 3 9
ditto, Pref.	2 16 3	2 15 0
TIN:		
Aramayo Mines (25 fr.), Bolivia	14 6	16 3
Associated Tin (5s.), Nigeria	4 0	3 9
Ayer Hitam (5s.)	10 3	10 6
Bangrin, Siam	11 0	10 6
Bisichi (10s.), Nigeria	4 0	3 9
Chenderiang, Malay	1 6	2 0
Consolidated Tin Mines of Burma	3 0	3 0
East Pool (5s.), Cornwall	6	6
Ex-Lands Nigeria (2s.), Nigeria	1 3	1 3
Geevor (10s.), Cornwall	2 0	2 0
Gopeng, Malaya	1 12 6	1 13 9
Hongkong (5s.)	12 6	13 0
Idris (5s.), Malaya	6 6	6 6
Ipoh Dredging (10s.), Malay	15 6	15 0
Kaduna Prospectors (5s.), Nigeria	4 0	3 9
Kaduna Syndicate (5s.), Nigeria	8 9	8 9
Kamunting (5s.), Malay	5 3	4 9
Kepong, Malay	9 6	9 6
Kinta, Malay (5s.)	6 6	6 3
Kinta Kellas, Malay (5s.)	5 6	5 6
Kramat Pulai, Malay	1 0 9	1 2 0
Lahat, Malay	5 0	5 0
Malayan Tin Dredging (5s.)	15 6	16 0
Naraguta, Nigeria	7 6	7 6
Nigerian Base Metals (5s.)	6	6
Pahang Consolidated (5s.), Malay	4 6	4 6
Penawat ($1), Malay	1 0	1 0
Pengkalen (5s.), Malay	10 0	11 0
Petaling (2s. 4d.), Malay	7 6	7 9
Rambutan, Malay	5 0	5 0
Renong Dredging, Malay	14 6	13 0
Siamese Tin (5s.), Siam	7 3	7 3
South Crofty (5s.), Cornwall	2 9	2 6
Southern Malayan (5s.)	9 3	10 0
Southern Perak, Malay	1 2 6	1 2 6
Southern Tronoh (5s.), Malay	6 0	6 0
Sungei Besi (5s.), Malay	7 0	7 0
Sungei Kinta, Malay	9 0	8 6
Tanjong (5s.), Malay	7 0	6 6
Tavoy (4s.), Burma	4 0	4 0
Tekka, Malay	13 0	13 0
Tekka Taiping, Malay	11 0	11 3
Temengor, Malay	1 6	1 6
Toyo (10s.), Japan	1 6	1 6
Tronoh (5s.), Malay	12 9	13 3
DIAMONDS:		
Consol. African Selection Trust (5s.)	6 3	7 6
Consolidated of S.W.A. (10s.)	2 3	2 6
De Beers Deferred (£2 10s.)	3 8 6	3 11 3
Jagersfontein	15 0	16 9
Premier Preferred (5s.)	1 2 6	1 3 0
FINANCE, ETC.:		
Anglo-American Corporation (10s.)	7 6	7 6
Anglo-French Exploration	10 0	10 0
Anglo-Continental (10s.)	2 9	2 9
Anglo-Oriental (Ord., 5s.)	6 6	6 0
ditto, Pref.	8 6	8 3
British South Africa (15s.)	18 3	18 9
Central Mining (£8)	5 15 0	6 5 0
Consolidated Gold Fields	15 0	15 6
Consolidated Mines Selection (10s.)	5 3	5 0
Fanti Consols (8s.)	5 0	5 3
General Mining and Finance	15 0	15 0
Gold Fields Rhodesian (10s.)	3 0	3 0
Johannesburg Consolidated	1 1 0	1 1 0
London Tin Corporation (10s.)	10 9	10 0
Minerals Separation	2 5 0	2 5 0
National Mining (8s.)	3	3
Rand Mines (5s.)	2 18 0	2 17 6
Rand Selection (5s.)	7 9	7 6
Rhodesian Anglo-American (10s.)	7 0	6 0
Rhokana Corp.	3 5 0	3 0 0
Rhodesian Selection Trust (5s.)	6 6	6 0
South Rhodesia Base Metals	2 0	2 0
Tigon (5s.)	3 6	3 6
Union Corporation (12s. 6d.)	2 9 6	2 6 3
Venture Trust (10s.)	3 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.

A DRAINAGE TUNNEL IN NORTH WALES

In the *Bulletin* of the Institution of Mining and Metallurgy for January J. L. Francis and J. C. Allan describe the driving of a mines drainage tunnel in the Halkyn district of North Wales, and extracts from their paper are given here. The authors state that the Halkyn district in North Wales has been the seat of a prosperous lead-mining industry at various times since the days of the Roman occupation of Britain and the tunnel is being driven with the object of reviving the industry in the Halkyn and Llanarmon areas, situated in Flintshire and Denbighshire respectively.

Geology of the District.—A Carboniferous limestone series striking north-west and south-east lies between the earlier Silurian rocks to the west and coal measures to the east. The formation has a comparatively flat dip to the east passing under the coal measures. The limestone series contains beds of shale, and is cut by a series of fissures in two main directions, one east and west, termed " veins," and the other north and south, locally known as " cross-courses." The veins, more especially, are mineral-bearing and of earlier formation than the cross-courses, the mineralization occurring in shoots which are confined to certain beds often directly below a shale bed or similar impervious strata, following the inclination of the beds which is normally about 1 in 6 to the east.

The history of mining in the district during the last century has been that of a constant struggle against the heavy water encountered. Normal precipitation would account for roughly 3,500 gallons per minute only, but, as the present flow from drainage tunnels amounts to an average of some 12,000 to 15,000 gallons per minute throughout the year, it is obvious that precipitation alone is not responsible. The River Alyn, which is largely fed by rainfall on the Silurian formation, crosses the limestone, and it is known that a large part of the water from this river finds its way into the mines down fissures. Normally, the east and west fractures or veins do not form important water channels, whereas the north and south cross-courses are often water-bearing. This results in a complicated network of water flow, so that it is not possible to predict when workings, at present comparatively dry, may strike heavy water through the intersection of a water-bearing fissure. One by one the various mines which have been favourably placed have struck heavy water and have been forced to abandon active work. This, however, has not prevented a few of them from mining to a depth below sea-level, and establishing the fact that mineralization can be expected to continue to similar depths in other veins of the district.

Historical.—Early records of lead-mining in Flintshire and Denbighshire are lost, but there is no doubt that it has been carried on for many hundreds of years. The discovery in the neighbourhood of pigs of lead bearing the stamp of Roman emperors, with the remains of Roman smelting works and various place-names, all testify to its antiquity.

In order to obviate the pumping difficulty, the Halkyn District Mines Drainage Co. was formed under an Act of Parliament, in 1875, to continue an adit which had been started in 1818 at about 170 ft. above ordnance datum. This was driven, including branches, a total distance of about 5 miles, and led to a portion of the Halkyn area producing 20% of the British production for a number of years. In 1897, the Holywell-Halkyn Mining and Tunnel Company commenced a sea-level tunnel from Bagillt, on the estuary of the river Dee, with a view to draining the mines in the Holywell or northern area.

The years immediately preceding the War showed a rapid decline in production as the workings approached the level of the Halkyn Drainage Company's tunnel, and pumping became necessary to continue an output. The Drainage Company, in 1913, therefore, obtained a new Act of Parliament authorizing them to extend the Holywell-Halkyn tunnel some 16,500 ft., and under agreement with the Holywell-Halkyn Company the tunnel was driven to Windmill, at the northern boundary of the Halkyn drainage area, in 1919.

The first step which had to be taken before the work reviewed in the present paper could be undertaken, was the amalgamation of all the interests involved, which entailed long and intricate negotiations, so that it was not until early in 1928 that this was effected. Financial arrangements, which had been dependent on the successful conclusion of the negotiations for amalgamation, were crystallized, and the Spring of 1928 saw an intensive investigation into modern tunnelling methods with a view to determining the most suitable method to meet the peculiar needs of the situation.

It must be borne in mind that in modern tunnelling, speed is largely a function of the amount that can be spent per foot. The capital involved in this instance was not large enough to justify any very serious expenditure to obtain speed ; so that, in this particular, comparison with tunnels where the necessity for speed outweighs all other considerations is difficult. The problem therefore resolved itself into adopting a system that would provide the maximum speed within the limits of the capital sum available.

The considerations that led to the adoption of the methods finally employed are considered under the following three broad headings : 1, Breaking Ground ; 2, mucking ; and 3, transport.

1. *Breaking Ground.*—Modern drills by reputable makers are not widely different in their performance. Accordingly it was laid down that drills would only be bought " at the tunnel face " and

drill firms were invited to send the drills they considered most suitable for the work for a competitive test under working conditions. The air-line was provided with a gauge near the face and the drilling speed from pitching to completion of each hole over six shifts was recorded, timing being done by representatives of both manufacturers and company. The type of drill finally decided on was the Ingersoll-Rand S70, 4 in. cylinder, with 42 in. feed, weighing about 210 lb.

A start was made using a drill carriage by a well-known maker equipped for four drills. The difficulty of handling this machine past the mucking device described below, however, counteracted any advantage that it might have. It was accordingly discarded in favour of two vertical columns, and finally a horizontal bar, which continues to give satisfaction.

2. *Mucking.*—Three ways of handling this problem were available, viz. : (*a*) Manual Labour, (*b*) mechanical Shovel, and (*c*) scraper. Scraper-loading, though in its infancy, had already produced some remarkable results. It had the advantage that its first cost was not high, repairs were easily made, and, as far as motive power was concerned, consisted of a unit that was standard and in regular use. One could therefore expect regular service on the machine. Accordingly, the assistance of the Sullivan Machinery Company was enlisted, and a scraper slide of their design mounted with a 6½ h.p. double-drum compressed air hoist was purchased.

Briefly, this unit can be described as follows : The scraper consists of a box or hoe of suitable design, each end of which is attached to a rope. The rope attached to the rear end of the scraper passes round a suitable pulley fixed as near as possible to the face, and thence to one of the drums. The rope attached to the front end of the scraper first passes over a pulley at the rear end of the slide before attachment to the other drum. The slide consists essentially of a ramp, up which the scraper loaded with material is drawn, with an extension to carry the material over the tub or wagon to be filled.

The scraper is drawn back empty, to a point near the face. It is then drawn towards the frame, gathering its load in transit. This is drawn up the ramp and over the loading platform, through which the material falls into the waiting tub. It will be understood that as the scraper is drawn over the spoil, the friction is great and that therefore the unit must be exceptionally strong in construction to stand the very rough usage encountered. There is, however, no question that the loading of broken material can be quickly and efficiently handled in a tunnel face without undue replacement costs.

3. *Transport.*—In order to extend the tunnel a distance of approximately half a mile from the 1919 face to Penybryn Shaft, Caeau Shaft was re-opened, and the tunnel re-conditioned for about 5,000 ft. At about half this distance two feeds of water, aggregating about 6,000 gallons per minute, had been encountered in a vug crossing the tunnel transversely. This section of tunnel was not more than 8 ft. by 8 ft. in cross-section ; the track was under water, and as it was obviously out of the question to build a bridge above the water or to enlarge the cross-section by stripping the whole length, a compromise was effected by building up one side with spoil from the face, and re-laying the track at the higher level.

As the length to be driven from Caeau Shaft was comparatively small, and as the old steam plant was available, which, with the addition of a drill sharpener, etc., was considered capable of performing the work, the installation of electrical plant, comprising battery-charging equipment for storage battery locomotives, was deferred until the Penybryn shaft was available as the base of operations. This decision was strengthened by the lack of space available due to the modification of cross-section mentioned above, and it was therefore decided to utilize ponies on the Caeau-Penybryn section.

Penybryn shaft, having been connected to the line of tunnel by a short cross-cut, was reached in July, 1929, and the base of operations was transferred there the month following.

Power.—Power is purchased from the North Wales Power Company, who bring in a line at 11,000 volts, 3 phase, 50 cycles, which they transform to 400 volts, the purchasers being metered on the low pressure side, and the supply has so far proved to be very well maintained, interruptions having been negligible.

Power House.—The power house, in which are housed the necessary switch gear and starters, together with the air compressors, winder, and 5-ton overhead travelling crane, is constructed of a framework of steel joists, filled in with timber sections, and a galvanized corrugated iron roof, the whole being designed for easy removal to another site. The floor is of concrete, with cable ducts covered by cast-iron plates.

Air Compressors.—There are two vertical air compressors, each of 515 cu. ft. capacity, by Belliss and Morcom. They are two-stage, two-crank, self-lubricating, and each is direct driven by a 108 b.h.p. motor, fitted with brush lifting and short-circuiting gear, by the Lancashire Dynamo and Motor Company. The compressors are set to unload at 100 lb. per squ. in. and take up load at 95 lb. per squ. in. The air receiver, which is situated immediately outside the power house, is coupled to a air pressure recording gauge in the office. One compressor suffices for ordinary routine work, and each works for 12 hours per day only.

Hoist.—This was made in Birmingham and power is supplied by a 45 B.T.H. motor. The drums are 5 ft. in diameter, and the winding speed, originally 250 ft. per minute, has been increased to 360 ft. per minute. Overwinding and overspeed devices are fitted.

Headgear.—The headgear is of girder and channel iron construction and is 35 ft. in height, with rope sheaves of 6 ft. in diameter.

Blacksmith's Shop.—This is equipped with No. 50 Ingersoll-Rand sharpener, oil furnace, grinder, etc., and is adjacent to the shaft.

Penybryn Shaft.—The shaft is 9 ft. by 7 ft. by 800 ft. deep. It is masonry-lined through shale for about 50 ft., the remainder being unsupported in limestone. Two 1¼ inch-diameter rope guides for each cage are used, and each is kept taut by 3 tons of cheese weights in a sump 17 ft. in depth. In dry weather a tank, which fills and empties automatically, is attached beneath each cage for the supply of surface water.

The shaft station is 12 ft. wide by 8 ft. in height, and sidings are provided for electric locomotives. The sidings are carried on a timber bridge, allowing a waterway of 12 ft. by 1 ft. 4 in. underneath. They are illuminated by electric light, which is not carried further underground. A grating, con-

structed of old drill steels, has been fixed at the face end of the bridge, which prevents the passage of any timber, etc., under it.

Ventilation, etc.—The fan, which is a No. 6 Sturtevant "Monogram" is designed to exhaust 4,000 cu. ft. per min. through 1½ miles of 20 in. pipe. It is housed in a chamber on the sidings, and is driven by a 20 h.p. drip-proof S.C. motor at 2,800 r.p.m. The fan is under the charge of the man at the shaft bottom, whose duty it is to start it up when a shot is fired, and at such other times when instructed to do so by telephone from the face.

The ventilation line is carried to within about 100 ft. of the face, and occasionally one or two of the leading pipes are damaged, but this is guarded against to a great extent by fixing a damaged pipe at the end.

The fan runs at full speed for about one hour after each blast, and sometimes at about half-speed at intervals during the shift, the total time of running being about one-third of each shift.

The ventilation pipes are of special construction, and are made of 18-gauge sheets. They are much strengthened by the corrugated rings, which also act as a shoulder for the joints. It is not easy to secure perfect joints on the pipes, which are now second-hand, having already been used in the Caeau-Penybryn section, but, after numerous experiments, the difficulty is being got over by using a special putty composed of whiting, engine oil, and resin, and afterwards painting the joint with bitumen solution. This putty always remains plastic, and it was found that a hard-setting putty was liable to crack and be displaced through the concussion of the shots.

The ventilation line is suspended as high as possible by No. 10-gauge galvanized fencing wire, attached, as a rule, to wooden plugs fixed in old sockets of the right-hand roof holes. The 5 in. "Victaulic" air line, the joints of which are remarkably tight and convenient, is carried immediately below the ventilation line on supports made out of old drill steel, which are driven into holes specially drilled in the side, and the 1½ in. water line is suspended from the air line. Owing to the necessity of excavating a grip, all pipes are carried in the above manner, and it has proved to be very satisfactory.

The tunnel is 10 ft. wide by 8 ft. high, and the grip about 4 ft. 6 in. wide by 2 ft. 6 in. in depth. The gradient is 1 in 1,000. Enamelled iron tallies are fixed every hundred feet on the side of the tunnel, and have been found most useful for purposes of reference.

Except at rare intervals, when passing through cross-courses, etc., no supports are necessary.

Battery Locomotives.—These are two in number and have been specially designed to meet the wet conditions obtaining. They are fitted with Exide-Ironclad batteries consisting of 30 cells, 290 ampère hours' capacity at the 5-hour rate of discharge. An ampere-hour meter is arranged for automatic termination of the charge. Illumination of the track for some distance ahead is obtained by means of a swivelling spot light, fixed on a standard well above the battery containers. The locomotives are designed to deal with a net load of 12 tons at a speed of 6 miles per hour, but commonly haul 15 tons at this speed. The weight of a locomotive, including batteries, is 2¼ tons.

One locomotive suffices for the work, the second being held in reserve in case of breakdown. They have proved to be efficient, and have given little trouble.

There are three sets of batteries for the two locomotives, charging being done on surface by a plant capable of dealing with two sets simultaneously, and situated near the shaft. The work is done by the locomotive driver, unaided, in about 15 minutes, the batteries being conveyed to the surface and charged on trolleys. Each set of batteries lasts for about 8 hours.

Track and Cars.—The gauge of the track is 22½ in. and flange rails weighing 25 lb. per yard are employed. Timber sleepers, to which the rails are spiked, are laid at intervals of about 3 ft. End-tipping cars, of a capacity of about 16 cwt., with roller bearings, are used, their size being to a great extent determined by the dimensions of the shafts available.

Drills and Drilling.—Two Ingersoll-Rand S70 drills weighing 210 lb. apiece with 42 in. feedscrews, are used, mounted on a 4½ in. horizontal bar. The latter is fitted with a ratchet-tightening device, in place of the ordinary screw, and has been specially designed for the job. It effects a great saving in time, as, with the ordinary tightening screw, it occupied 4 or 5 men from 20 to 25 minutes in jacking up, whereas one man, with a second to complete the tightening, can now do the work in less than 5 minutes. Another advantage is that the locking device precludes the slackening of the bar during drilling. Inasmuch as the bar is jacked three times per round, i.e. twice for drilling and once for mucking, it allows of from two to three cuts extra per week, and whereas with the old type of bar the greatest number of rounds shot in a week was 23, and that figure but rarely attained, it is now common to shoot 25 cuts, and the record has been 27. The bar is, of course, considerably higher in price than the old type, but the advantages in its employment are so great that it will be surprising if a somewhat similar design is not adopted as standard in all work in which time is an important factor.

Before drilling a round, the ganger is responsible for checking alignment and elevation, and this is done by the following method: Centre spuds are lined in by theodolite every 100 ft. and from these are hung standard candlesticks. The height of the candle flame, which just shows above the candlestick, is adjusted to give an inclination of 1 in 1,000, the line given being 5 ft. above track level. The ganger, by sighting two candlesticks, is, therefore, able to direct a man at the face to fix both centre and elevation by means of a smoke mark from his lamp. Five feet on each side of the centre and three feet above elevation mark for roof-level are then measured off and marked in a similar way. The method has been found to be both expeditious and accurate.

The drills and drilling gear are taken to the face in cars behind the slusher, and stored on the side of the track at a convenient distance behind the slide. On completion of slushing, the bar is taken down and re-fixed in position for drilling the upper part of the heading. Meanwhile, a rough stage of planks has been rigged up, upon which the drills and gear are placed, and afterwards fixed in position by the two drillers and their two helpers. Each man is assigned a particular job, and no orders are necessary.

Air is carried from the 2 in. cock at the end of the 5 in. air main by a 50 ft. length of 2 in. india-rubber hose, which supplies a manifold, whilst water is taken to the water manifold by a 50 ft. length of 1 in.

hose. The air manifold is supplied with three 1 in. and one ¾ in. and the water manifold with three ½ in. branches. The water supply is piped from an upper level in the shaft and registers a pressure of about 80 lb. per squ. in. at the face. One manifold branch in each case is for connexion to a 75 lb. X59 Ingersoll-Rand water-feed jackhammer, used for drilling the grip holes, whilst the fourth branch on the air manifold can be connected to a second jackhammer when required. Cut holes, of which 8 are drilled per round, average about 7 ft. 6 in. in depth, whilst the remainder average about 6 ft. 6 in. Owing to the long feed-screw, all holes are drilled with one change of steel only. The limestone can be drilled easily, but, being massive with no stratification, breaks badly, so that 36 holes are put in, with an average of 5 holes, about 5 ft. in depth, for the grip. These latter are drilled downwards about 12 ft. behind the face, and are shot with the round.

In the past, attempts have been made by several expert tunnellers to reduce the number of holes per round, but they have not met with success, and the round used has proved to give the best results, particularly as regards the accumulation of the muck pile close to the face.

The average time for drilling a round of 36 holes is about 2 hours 18 minutes, and the fastest time achieved has been 1 hour 30 minutes. The S70 drills penetrate the rock at from 24 in. to 30 in. per minute. A plentiful supply of sharp steels is maintained in a steel rack within a reasonable distance of the face. The total length of holes drilled per round is about 270 ft., and the average number of steels sharpened after each round is 21·7, the average number of breakages per round being 1·46, about 85% of which are at the shank end of the steel.

The length of starters used has doubtless some bearing on breakages. These are cut 4 ft. 6 in. long beneath the shank, and sharpened with bits 1⅝ in. in diameter, and the diameter of the bits for finishing steels is 1½ in., the limestone, although hard of its kind, not being abrasive. Hollow round steel, 1¼ in. in diameter, is used for both the S70 and X59 drills.

Blasting.—As soon as the drilling gear has been removed from the face, all holes are blown out, which operation occupies about 6 min. Meanwhile, in order to comply with Government regulations, the necessary supply of explosives and tamping has been brought in in wooden boxes holding 40 lb. each. These boxes are divided into 8 compartments, each of which holds a tin canister filled with 5 lb. of 1⅜ in. diameter No. 1-60% Arctic Gelignite, individual cartridges being half a pound in weight. Primers and tamping have been prepared during the slushing shift. Charging is done by two drillers, one of whom also acts as ganger. Each driller has a man in attendance, who hands him explosives, and the tool nipper is in charge of the box containing primers, which is partitioned into 8 divisions for holding Instantaneous and Nos. 1 to 7 Sextuple Delay-Action detonators. The detonators are specially made by Nobel's Explosives Co., and are described as "intermediate," having stronger insulation than the ordinary type, and not being so well insulated as those described as "submarine." This type of insulation has been found to be satisfactory even in wet holes. Instantaneous detonators are fitted with 72 in. wires, whilst the remainder have 84 in. By special arrangement with the manufacturers, the label showing the number of delay is attached to the wires in such a position that it hangs outside the hole after the completion of charging, and so enables a check to be made. Primer cartridges are placed last in the hole, except in the case of the "easer" holes, in which they form about the third cartridge from the bottom, in order to guard against "cutting out."

Tamping is made up of stiff clay, wrapped in old newspaper, in cartridges of about 5 in. in length. They are made by hand during slushing, and naturally vary in diameter, but arrangements are being made to obtain regularity by the use of a sausage-filling machine to give a cartridge 1⅛ in. in diameter. From four to six cartridges of tamping are used for each hole.

Holes are connected up in series and, on the completion of loading, the ganger carefully examines each connexion. The whole circuit is then tested by galvanometer through about 400 ft. of twin cabtyre cable and 300 ft. of connecting wire, loosely hung over the supports for the pipe lines. During loading the muckers shovel debris from the last shot to form a bank of about 2 ft. in height across the level at about 20 ft. from the face, the object of this being to confine the muck in a pile as near the face as possible. Meanwhile the main valve on the air-line, situated from 200 ft. to 900 ft. from the face, has been closed, and the 2 in. cock at the end of the line has been removed. The end of the air-line is protected by a 2 ft. length of 10 in. pipe, one end of which has been bent over so as to close it, and immediately behind which is a buffer made of waste air hose. The 1½ in. cock on the water line is protected in a similar manner by a piece of 6 in. pipe.

The firing of the shot is done by a 50-shot "Atlas" exploder, the shot firer being protected by the slusher slide, 600 ft. to 800 ft. from the face. Immediately after the shot is fired, i.e. about half an hour after the completion of drilling, the fan is started up, and the main air-valve is opened, the pressure of the air sufficing to blow off the protection cap from the end of the pipe line. After an interval of about 5 minutes, the ganger and his assistant proceed to the face and examine it to ascertain the effect of the shot. They take with them a 5 lb. canister of explosives with the necessary tamping and primers, made up with ordinary safety fuse, and if any "sockets" or "guns" are found, charge them up before leaving. After a further interval of about 15 minutes for the clearing of fumes, men go in to clean up the track, and the locomotive comes up behind the slusher with a train of about 25 empty cars, the leading ones of which contain the drilling gear, and pushes the slusher in advance of the train up to the skirt of the muck pile, afterwards switching the empty cars into the loop.

The average time from the firing of the shot to the commencement of slushing is 48 minutes. The average quantity of explosives used per foot for a cut of 6·23 ft. is 22 lb., which includes from 1½ lb. to 2 lb. per foot for the excavation of the grip.

Consumption of explosives is admittedly high, but all efforts to reduce it without adversely affecting the footage have so far been unsuccessful. The rock is generally massive, stratification being rarely met with, and, to use a local miner's term, it is "springy." Factors which lead to high consumption may be set down as :—

(1) The speed at which holes are put in, the tendency being to spend too little time in directing them to the best advantage.

(2) The length of cut, i.e. about 65% of the width of the heading, which is high for limestone.

(3) The serious loss of time caused by re-shooting leading to a tendency to overcharge in order to make certain of the hole breaking.

(4) The charging of all holes in one operation being more wasteful in explosives as compared with the old method of shooting the "cut" holes, followed by the charging and shooting of three or four outer rings separately.

With regard to No. (2). The old district allowance for a 3 ft. cut in a level 7 ft. square was about 8 lb. of blasting gelatine per foot, whereas the average quantity used to pull a 5 ft. round in a level 8 ft. square was about 12 lb. a foot.

The first 3,000 ft. driven were shot with ordinary safety fuse, so arranged that the shots went off in the order desired, but delay action detonators are now standard, and they have led to a saving in time for clearing fumes.

Considerable trouble has been experienced with regard to re-shooting, the average for safety fuse having been 6·82%. One of the reasons for substituting electric detonators was in order to reduce this, but it was found, after four months' experience of this method, that the figure still remained at 5·97%. Now, however, by the substitution of a better insulated detonator, it has been reduced to 2·93%, including re-shooting due to all causes, e.g. holes failing to break, guns, sockets, faulty detonators, etc., etc.

Scraper Loading.—Speed of loading largely depends upon the supply of empty cars, and to ensure this, a loop for storing 30 to 40 of them is carried to as near the slide as possible, say 20 ft. to 30 ft. Cars enter the loop through a switch, which is moved forward when required, the time occupied for its removal and re-fixing being about 30 minutes. The simplest and quickest method of transferring empty cars from the loop on to the full line behind the slusher has been found to be by skidding them over flat plates. Two men do this immediately the full car has passed the plates, and run the car under the slide, afterwards bringing out the loaded car for storage on the main line opposite the loop.

At the outset, the pulley at the face was attached to the bar by means of a chain, but it was found that it would not always take up the plane of the rope, which was subject to frequent jamming and consequent damage. The chain has now been replaced by a loose clamp, made in our own workshops, which is held in position laterally on the bar by means of an ordinary drill safety clamp, allowing of free movement in a vertical plane. A special type of pulley, also designed and made on the mine, is attached to the clamp by means of a vertical bolt on which it can swing horizontally, so that there is free movement in both vertical and horizontal planes. This pulley was designed to prevent the jamming of the rope between the sheave and frame, as we were unable to discover one on the market which was really suitable for the work. By its use, the trouble has been entirely eliminated.

Both box and hoe type scrapers have been tried, the former giving by far the better results, and now being standard. Hoe scrapers have their uses when rock fragments are large, but in this case the rock usually breaks small.

In the original scraper supplied, the manganese steel wearing plates were $\frac{5}{8}$ in. thick only, and broke frequently. These have been replaced by plates $\frac{3}{4}$ in. in thickness of the same material. Rivets were $\frac{5}{8}$ in. diameter and gave constant trouble, and have been replaced by $\frac{1}{2}$ in. The $\frac{3}{4}$ in. countersunk-head bolts for attaching wearing plates to the scraper have been replaced by $\frac{3}{4}$ in. cup-head, square-necked bolts, as it was found impossible to tighten the nuts on the former when rusted and worn by use, whereas the new type, being square under head, are held in the square holes of the wearing plates. The sides of the apron on the slide have been increased 12 in. to a height of 24 in., in order to prevent the scraper from fouling the uprights supporting the hoist platform. Detachable and adjustable back stays have been fitted to carry the weight at the rear end of the slide, and stays have been fixed also to strengthen the rear vertical pulley.

The slide is pushed right up to the muck pile to within about 30 ft. of the face, and rail clamps are not used. In order to avoid the scraper fouling the rectangular ends of the track, short pieces of rail, cut and shaped, are fixed by fishplates to the ends of the rails.

An improved form of rope guide has been improvised on the mine, as that supplied with the hoist was unsatisfactory. The same applies to the air filter, which was made of brass gauze, conical, of short length, and only $\frac{3}{4}$ in. in diameter. The area was therefore small, and the rush of air at about 90 lb. pressure tended to destroy the thin gauze wires. It has been replaced by one of much greater area, in which the holes are drilled in a thin brass sheet. This type has given very satisfactory results, and has obviated the stoppages due to dirt entering the turbine through damage to the wires in the original filter.

Two double-drum Turbinair hoists are available. One is carried as a spare, and can be put to work in $1\frac{1}{2}$ hours or less. Whilst the hoists have given excellent results there is a danger that, as practice has improved, too much may be required of them, and they are to be replaced by one of 15 h.p.

Two scraper loads normally fill a car, and the practice is to run the scraper backwards and forwards to the face during the spotting of cars, thus collecting a pile of muck at the foot of the ramp, and ensuring that full scraper loads will be delivered into the car. By this means, full cars are run out at intervals of approximately one minute during the time the hoist is running, the average time taken to load a round of about 54 cars being 1 hour 19 minutes, and the record for loading 52 cars being 55 minutes. During slushing, work is suspended only for moving the pulley at the face to the position required on the bar, and for shovelling the muck from the sides into the path of the scraper.

Whilst it is possible by turning over the scraper to clean completely the sides of the level near the face, it has been found that within 15 ft. or so of the slide it is more expeditious to shovel the muck from the sides into the path of the scraper. It is obviously inadvisable to muck the grip beyond the skirt of the muck pile, and the necessity for the provision of a loop for empty cars as near the face as possible renders it difficult and expensive to open the grip beyond the switch entering the loop. It is therefore not mucked beyond this point, and is later cleaned out by manual labour. A small temporary grip is carried forward to the face, and is sufficient to drain the water used in the drills and any small feeders intersected.

Transport.—Certain details in connexion with the duties of the electric locomotives have been mentioned under earlier headings. Track and transport are under the charge of two traffic superintendents, each responsible for 12 hours, whose duties include also the maintenance of the necessary supplies at the face. The locomotive, having

pushed the slusher to the face and filled the loop with empty cars, stands by until a sufficient number of cars to make up a train has been filled. It then runs out to the shaft with trains of 12 to 15 cars, or gross loads of, say, from 13 to 18 tons, and replaces the full cars with empties each journey.

The system of haulage has proved to be very adaptable, and the cost for the fourteen weeks ended July 5, 1930, during which the advance was 2,037 feet, under normal conditions, was £219 12s. 5d. Thus, exclusive of traffic superintendents whose duties comprise much more than the supervision of haulage, the cost works out at 2s. 1·8d. per foot, 3·86d. per ton nett or 4·93d. per ton (nett) mile, the average distance to the shaft during the period having been 4,128 ft. Excluding wages, interest and depreciation, the cost for current and upkeep amounts to 0·55d. per ton (nett) mile, compared with 2d. per ton mile, which was the cost of pony haulage on the same basis.

The above figures include all costs of shunting at the face and shaft, taking men in and out, transport of stores, also pushing the slusher to the face for about 700 ft. and returning it each round.

Labour.—The labour force employed is as follows: Underground, 53 men, the normal gang at the face being 12 men per shift. Surface: 28 hands. Work is carried on from midnight on Sunday to 6 p.m. on Saturday. Eight-hour shifts are worked to midnight on Friday, with six-hour shifts on Saturday. The men are taken in and brought out by locomotive, and relieve at the face, so that work is continuous for 138 hours per week.

Average time for cycle of operations.—Taking the four weeks ended July 12, 1930, the average time for a complete cycle was as follows:

	Hrs.	Mins.
Taking down slusher and setting up drills	0	31
Drilling 36 face and 5 grip holes, blowing out holes, charging and shooting	2	48
Clearing fumes, cleaning track, taking in and setting up slusher	0	48
Slushing 54 cars, say 43 tons	1	19
Average time for complete cycle	5	26

The period comprised 101 rounds, and gave a total advance of 653 ft. or 163·25 ft. per week. Average advance per cut, 6,465 ft. The record round was shot on Saturday, June 28, 1930, and details of the time table are given below:

Shot cut No. 25	1.40 p.m.
Commenced slushing	2.15 ,,
Completed slushing 42 cars	3.00 ,,
Commenced drilling cut No. 26	3.20 ,,
Shot 44 holes, cut No. 26	5.25 ,,

the complete cycle from shot to shot occupying 3 hours 45 minutes for an advance of 6 ft.

Bonus System.—A graduated bonus is paid on every foot of advance in excess of 108 ft. per week, based on one 6 ft. cut every shift. The system was originally designed so that the total labour cost of the tunnel, calculated at this rate of progress, could be earned by the men in such shorter time as they were prepared to work to earn it. Due to delays from sand, etc., experience proves that the company is losing from this point of view. However, the scheme is clean-cut and free from argument, and on the whole has worked well.

Costs.—Costs are made up on a fortnightly basis, full details being given in the paper.

NEW PRECIPITATION AND CYANIDE RECOVERY PROCESS

In the *Engineering and Mining Journal* for January R. M. P. Hamilton gives an outline of a precipitation and cyanide recovery process, which has been developed by the General Engineering Company. It will be recalled that a reference to this process appeared in the Magazine for June last. The author says that an efficient method of recovering inexpensively the cyanide and precious metal (if any) in the barren solution fouled by contact with cyanide-consuming ores has been developed by the patentees of the Geco process. Local conditions, of course, would govern the detailed application, but reference may be had to the flow-sheet in Fig. 1 for a general case.

Pregnant or barren solution is run into one of three receiving tanks having a storage capacity equivalent to two hours' flow of solution, or it can be treated continuously. If the cycle method is employed, the first tank will be allowed to fill, then the second, and later the third. When the first receiver is filled, titrations will be made to determine cyanide and lime content per ton of solution. Reference to a table such as is shown in Fig. 2 indicates an equivalent quantity of zinc sulphate added in the form of a 10% solution, or other convenient strength. After about an hour of contact, the resultant precipitate will have settled in white, easily filtered flocculles in the lower half of the tank. The pulp is then run through a standard Genter (filtering) thickener, which operates continuously from the discharge of one or other of the three receiving tanks. The Genter delivers a clear filtrate and a sludge product, the latter amounting to 2 or 3% of the original solution. The sludge is stored in a small receiving tank for subsequent regeneration of cyanide, the plant to accomplish which is operated on day shift only.

The Genter filtrate, in a decyanided condition, is neutral, free from fouling constituents, and contains only the cyanide combined with the gold or silver not previously precipitated If sulphocyanides occur, they can be precipitated by copper sulphate, sulphur dioxide, or other cheap reagent. To recover the precious metals, it is necessary to add to the decyanided solution enough acid to dissolve the weight of zinc chemically required to precipitate whatever quantity of gold and silver is present. The solution is then contacted with zinc, without evacuating or deoxygenating, and the precious metals are recovered in the form of a clean, high-grade precipitate. Zinc dust may be used with a standard type of filter press, or zinc shavings, according to local conditions. After contacting with zinc, these solutions may be regarded as "water," re-used in the mill, or run to waste if water is plentiful.

The Genter sludge goes to the regenerator—a lead-lined chamber having natural or forced draught connexions to the absorber for hydrocyanic acid. This is a contact chamber for fixing the regenerated gases in lime water, for re-use in the mill. When the regenerator is from one-third to one-half full of Genter sludge, sulphuric acid is added in proportion to the amount of cyanide and lime (or zinc sulphate) indicated by titrating the feed solutions, and by reference to the table shown

GENERAL FLOW-SHEET

PRECIPITATION AND CYANIDE RECOVERY PLANT

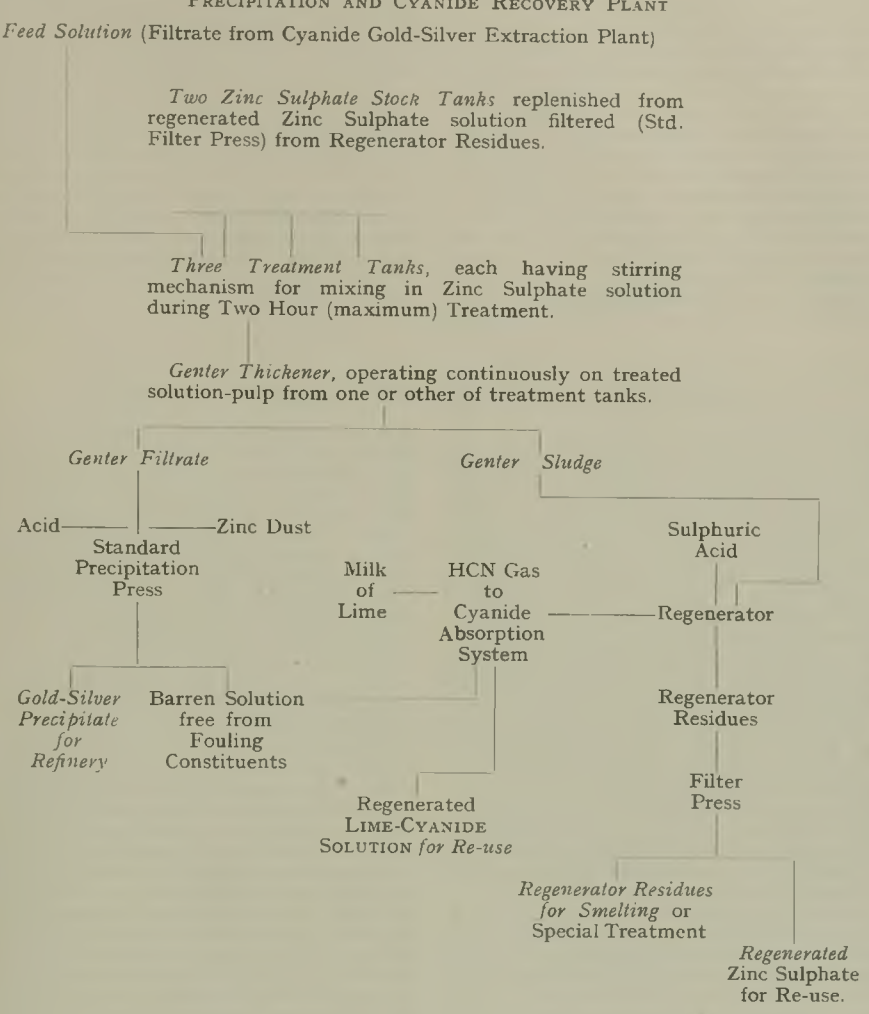


FIG. 1.

CHEMICAL EQUIVALENTS.

	2KCN	2NaCN	$Ca(CN)_2$	Zn(CN)	2KCN	CaO	H_2SO_4	$Ca(OH)_2$	$ZnSO_4 7H_2O$
##KCN . .	1·	0·753	·706	0·903	0·416	0·43	0·753	0·57	2·21
##CaO . .	2·32	1·75	1·64	2·1	0·965	1·00	1·75	1·32	5·14
NaCN . .	1·328	1·00	0·94	1·2	0·552	0·571	1·	0·756	2·94
2NaOH . .	1·62	1·222	1·15	1·47	0·675	0·7	1·222	0·925	3·6
$ZnSO_4 . 7H_2O$.	0·453	0·342	0·32	0·408	0·188	0·195	0·342	0·2575	1·0
Zn . .	1·990	1·50	1·4	1·8	0·830	0·857	1·5	1·13	4·4
$Ca(CN)^2$.	1·416	1·066	1·0	—	—	—	1·066	—	3·129

(*a*) ##KCN and ##CaO in solution are precipitated by their equivalent quantity of $ZnSO_4 . 7H^2O$.

(*b*) CuCNS precipitation : 249·7 $CuSO_4 \cdot 5H_2O$ + 248·2 $Na_2S_2O_3 \cdot 5H_2O$ (mixed) in equal proportions precipitate NaCNS, Cu, etc.

(*d*) Solubility of CaO in water is 0·14% at 0° C and 0·07% at 80° C. Solubility of $CaSO_4$ in water is approximately 1 part in 400, by weight.

FIG. 2.

herewith. Regeneration is aided by agitation for a period up to two hours. Samples of the regenerator solution will then be slightly acid to methyl orange. The cyanide, originally titrated in the feed solution and precipitated by zinc sulphate, will have been driven off from the regenerator charge as hydrocyanic acid gas and " fixed " as calcium cyanide ($Ca(CN)_2$) by the lime water in the absorber. The zinc sulphate originally consumed in precipitating the cyanide and the fouling constituents in the feed will have been regenerated by the action of the sulphuric acid, so the residual sludge is filtered to recover the regenerated zinc sulphate solution. The resultant filter cake, containing base-metal constituents such as copper and iron, may be handled according to commercial valuation.

The process is cyclical, its net chemical requirement being the sulphuric acid needed to regenerate the hydrocyanic acid from the zinc cyanide precipitate, plus the small amount necessary for gold and silver precipitation with zinc, and the lime required to " fix " the regenerated hydrocyanic acid in lime water. No white precipitate can be formed to block solution flow ; only the actual regeneration requires special attention, and this operation is carried out on day shift. Vacuum precipitation is unnecessary and the precious-metal precipitate is clean and high grade. Over 95% of the solutions going to the recovery plant may be re-used as fresh water in the mill circuits, which are thus kept active without the wastefulness of careful and troublesome handling of bulky solutions, which cannot otherwise be avoided except by sending fouled solutions to waste.

THE FLOTATION OF NON-SULPHIDE ORES

Technical Publication No. 445 of the American Institute of Mining and Metallurgical Engineers contains an account by W. H. Coghill and J. B. Clemmer of work on the soap flotation of non-sulphide minerals. The authors state that flotation has been so closely allied with the sulphide minerals and their early and associated oily reagents that the term " oil flotation " has erroneously been applied to the entire flotation process. To-day, the term " chemical flotation " might be used to advantage. Flotation literature has dealt primarily with the removal of sulphides from non-sulphide gangues, and the separation of one sulphide from another. Now, the application of the process to the separation of non-sulphide minerals is coming to the fore and, from the standpoint of the number of commercial minerals involved, the flotation of non-sulphides offers the larger field. Here, soap or soap-forming substances, such as the fatty acids and their derivatives, are used ; hence there may well be a subdivision of the chemical flotation process called " soap flotation." In the following paragraphs full extracts are given from this paper.

The authors continue by saying that early experimenters found that it was easy to form a froth or foam that would carry a part or all of the ore charge over the lip of the flotation machine, but that this could not be regarded as flotation because of the lack of selectivity. Doubtless soap was one of the first reagents tried and doubtless it was rejected on account of its gangue-carrying properties. Now this same gangue-carrying ability makes soap an acceptable reagent, for we are dealing with that, which among sulphides, is considered " gangue." As in the flotation of sulphides, so in the flotation of non-sulphides, the selective flocculation of the mineral and the dispersion of the gangue are the first objectives. In fact, these two phenomena epitomize flotation. They depend upon the unlike surface properties of the respective minerals and as long as the components of an ore have unlike surface properties, a separation is possible, at least in theory.

Often in non-sulphide flotation it makes little difference which mineral floats and which is depressed, as generally only a separation is sought. Also, for economic success, the separation does not always have to come up to the standards demanded in sulphide flotation. When two or more minerals in the ore are equally floatable, or when the minerals themselves are not pure, clean concentrates cannot be obtained. These conditions prevail more often in non-sulphide than in sulphide ores. However, some of the non-sulphide ores which have clean mineral grains have yielded soap-flotation concentrates as clean as the best sulphide concentrates. The metallurgical limitations are probably more inherent in the ore than in the soap flotation process.

Flotation research is largely a matter of trial to find the type and amount of reagents. This method is sound because flotation cannot be worked out on a test-tube scale. The manner of agitation and beating cannot be duplicated outside of an actual flotation machine and reagents cannot be split into sufficiently small quantities to permit duplication on very small scale with the accuracy required. Flotation deals with adsorption and solubilities in water in amounts of only a few parts per million. Flotation requires an emulsion of air in liquid. The emulsion is made possible and is stabilized by the addition of frothing agents. Pine oil has been the most common. Soap acts in the same capacity, but when used alone it makes a " suds," which is too tough and too stable to be satisfactory. Good flotation requires some bursting and coalescence. The rupture of elastic membranes at the surface often throws the small mineral grains to a distance of several inches. Doubtless similar coalescence of the emulsified air nuclei takes place within the pulp and this aids in dropping entrained gangue. It is fortunate that flotation is best when the bubbles are somewhat brittle, because if they did not break the froth would be so voluminous and permanent that its disposal would be difficult.

Although, as is commonly known, soap makes a suds, its rôle in the flotation discussed in this paper seems to be due to its selective adsorption. Selective adsorption implies the use of a bare trace of reagent, and in soap flotation the amount of soap rarely exceeds 100 to 150 parts per million parts of water. This small amount is generally enough to flocculate both the mineral and, to some extent, the gangue. This latter effect must be minimized by using alkaline dispersing agents like sodium silicate or sodium carbonate. Seldom is soap sufficiently selective to be used alone. As will be discussed later, pine oil generally is necessary to impart brittleness to the froth. Consequently, the term " soap flotation " is not strictly technical because the froths are regarded as modified pine-oil froths.

If colloid chemists have tested the frothing properties of mixtures of pine oil and soap, they must have reported that in certain ratios these reagents are incompatible. When a dilute soap solution is shaken in a test tube in the presence of an increasing amount of pine oil, its sudsing proclivities gradually disappear until no froth can be formed by shaking. With an excess of pine oil a froth again appears. The flotation tests herein reported were with insufficient pine oil to kill the soap suds, but with enough to enable a good selectivity. The addition of five parts, or more, of pine oil per million parts of water brings about the desired change in selectivity, which is recognized by the bursting of the bubbles before and after the froth has passed over the lip of the machine. The pine oil probably affects the degree of flocculation.

Sometimes the flocculation of the mineral is too intense. In an excellent paper by Ralston and Barker on flocculation, they call this "over-flocculation," and in accord with their observations, compact clots of mineral grains have been seen to come to the surface and fall back because they did not retain the quota of air nuclei sufficient to hold them at the surface. Under this condition the gangue also is flocculated, and it contaminates the froth. Phenomena such as these seem to be the only tenets for experimenters who claim that gangue, rather than mineral, should be flocculated. Sometimes the over-flocculation may be remedied with alkaline salts. In fact, so much sodium silicate may be used that the entire charge is again dispersed. Sometimes another addition of soap will reinstate flocculation, but it is better to start with a new charge in experimental procedure.

Reagents and Machines.—Sodium silicate is an important reagent in non-sulphide flotation, but unfortunately the term is not specific. The ratio of soda to silica is seldom considered. Many of the silicates were examined and, although any number of the series may be used, the ortho-silicates and meta-silicates were preferred. Bicarbonates are undesirable as alkaline dispersants. In fact, suspicion has rested on the carbon dioxide naturally contained in the air passed into the pulp. To determine the effect of carbon dioxide comparative flotation runs were made with natural and with "scrubbed" air. The latter, where the carbon dioxide had been removed by passing the air through a solution of caustic, gave the better results. If this observation is correct, pneumatic machines that employ contaminated air as a means of agitation should be avoided in soap flotation. Fatty acid reagents are changed instantly upon entering hard water. Very few non-sulphide ores are without the accessory soluble salts that make water hard. Some hardness is allowable, but the excessive amount of hardness induced by non-sulphide ores from the arid South-west has hindered good flotation. In the study of the effect of hard water, calcium oleate was prepared and used as a flotation agent. The flotation was satisfactory. An elevated temperature seems to make hard water more tolerable.

The non-sulphide minerals which possess distinct crystalline structure and lustre are the most floatable. Earthy minerals are generally difficult to concentrate. Wad manganese ores are especially difficult.

As would be expected, hydrogen ion determinations are difficult in pulps with the gangue so thoroughly dispersed as in soap flotation.

Strangely, sulphuric acid has been a valuable reagent in some of the soap flotation of non-sulphides. Sometimes it is used in the cleaning of the rougher concentrate, but, when the ore is free from gangue slime, it may be used advantageously in the rougher. When coarse gangue contaminates the cleaner concentrate a trace of dilute sulphuric acid will depress it.

Mechanical machines with a positive means for controlling the air are best. In some of the mechanical machines the leak of air through the stuffing box which constitutes a part of the aeration unit is objectionable because it prevents regulation of air through the valve. Mechanical beating in the presence of a moderate feed of air is best in soap flotation. In the work reported in the paper vertical-shaft mechanical agitation flotation machines were used. Air machines gave too much suds for soap flotation. The pulp densities were in accord with usual practice.

Limestone.—As early as January, 1925, a flotation test on calcareous iron ore showed that the limestone was floatable with a fatty acid. Subsequently Lee used oleic acid and cresol in the flotation of limestone from magnetic log-washer tailing. The iron ore, which was the source of the tailing, had previously received a reducing roast at 550° C., and the iron had been removed magnetically. The tailing from the magnetic machines was high in limestone and silica. Since the limestone was needed as a flux in the blast furnace it was desirable to recover it by flotation and add it to the iron concentrate. The siliceous flotation tailing was sent to waste. By this means a self-fluxing blast-furnace feed was prepared. A point of technical interest is that flotation worked satisfactorily on a feed that had been subjected to an elevated temperature, although the temperature was not high enough to calcine the limestone. The absence of sulphides probably favoured the process.

Phosphate Rock.—During the course of an investigation of the methods of washing the phosphate rock of the land-pebble district of Florida, soap flotation was tried on the fines in the waste. The phosphate rock was concentrated and a fine quartz sand tailing was rejected. Soap, pine oil, sodium silicate and sodium carbonate were the chief reagents. Under the protection of patents one of the Florida companies has been practising, intermittently at least, soap flotation of phosphate rock. In the pursuance of this investigation Lawrence and Roca continued the use of soap, but replaced pine oil with sodium sulphide. The notes on the flotation of phosphate indicate that the flocculation of the phosphate must have been intense, while the sand grains were dispersed.

Bauxite.—Bauxite ores are among the most unpromising for flotation. Sodium sulphide and oleic acid were the reagents. The froths were more voluminous than if pine oil had been used. No theory has been forthcoming to justify the use of sodium sulphide, and it has not been employed in any of the tests.

Fluorspar.—The flotation of fluorspar has long since passed the experimental stage. Soap and pine oil, or the equivalent of the latter, are fundamental reagents. In a paper by Coghill and Greeman the results of preliminary experimentation have been given, as also a warning against hard water because of its action on soap. Plant operations, however, have proved this statement to be over cautious, because moderately hard water has since been used successfully. This is natural, because calcium and

magnesium oleates, the reaction products of soap with hard water, are known to be moderately soluble.

Rhodochrosite.—Before the application of flotation, veins of rhodochrosite containing quartz and other gangue minerals were regarded as waste rock. Now they are valuable ore-bodies. The flotation concentrate is of good grade and it can be enriched further by calcining to drive off the carbon dioxide. When the ore contains sulphides, they can be floated ahead of the manganese mineral to produce a sulphide concentrate. In the laboratory soap and pine oil were the basic reagents. The laboratory results have been confirmed by commercial runs. When the rhodochrosite veins contain other carbonates the success of flotation will be impaired because all carbonates are floatable.

Manganese Oxides.—Some of the manganese oxides are so permeated with gangue that liberation by grinding is impossible. Some of them in arid districts, contain excessive amounts of soluble salts such as gypsum. When the soluble salts have had time to dissolve in the pulp they may cause trouble. On the other hand, some of the manganese oxides are amenable to flotation, a commercial flotation unit being now in operation in the Cuyuna district, Crosby, Minnesota.

Barytes.—Barytes generally occurs in residual deposits associated with clay, quartz, and iron oxides. The clay can be removed by log washing, but the iron oxides and quartz require some other method. Barytes is one of the most floatable of non-sulphides, but oleic acid alone will not give good concentrates. A small amount of alkali, either sodium carbonate, hydroxide, or silicate, readily disperses the gangue and induces a richer froth. Too much dispersing agent gives an undesirable " watery " froth. Losses of slimed mineral increase with the alkali, and complete dispersion may result should the amount of alkali be excessive. Sodium silicate requires closer reagent control than the carbonate or the hydroxide. The results of a test on an Arkansas ore are shown in the paper, the reagent list showing that sodium silicate was used in the cleaning. The iron, which is often penalized by the buyer, was reduced from 0·65 to 0·11%. Not all barytes ores are amenable to flotation. Other sulphates or carbonates float too freely and they also will go into the concentrates and reduce the grade.

Siderite.—On account of the interest of investors in a body of siderite in Texas, a sample was sent to the U.S. Bureau of Mines for examination. Although siderite, like other carbonates, is readily floatable, the sample gave trouble because the gangue contained a partly water-soluble mineral resembling glauconite. Quantitative tests showed that some lime and a large amount of magnesia dissolved in distilled water. The ore required grinding to 48 mesh for liberation. Removing the water contaminated during wet grinding and using fresh water in flotation gave good results. Precipitating from the contaminated water the soluble salts, by a lime-soda ash or a caustic soda treatment, also allowed good results to be obtained in flotation. As the precipitate in the latter method did not cause trouble, it was not removed from the pulp.

Chromite.—Chromite samples from California and Montana were tested. The sample of California chromite contained small crystals of the mineral disseminated in gangue predominantly serpentine (hydrous magnesium silicate). The clean mineral grains contained 55% of chromic oxide. Several preliminary flotation tests fell short of expectations; concentrates of good grade were made with little difficulty, but the recovery was low. The reagent charge included nominal amounts of pine oil, oleic acid, sodium oleate and sodium carbonate. Soon after starting, the froth became so unstable that no more mineral floated. Addition of more reagent failed to assist in promoting flotation. Further tests showed that the serpentine or some other gangue mineral was somewhat soluble in water; hydrogen ion tests on water after contact with the ore revealed that the water was decidedly alkaline. Qualitative tests showed some calcium and a large amount of magnesium carbonate or bicarbonate salts in solution. Similar tests conducted in the presence of sodium carbonate revealed that it accelerated the rate of solution of the gangue. Thereafter carbonates were omitted and an extra amount of soap and sodium hydroxide was used. It seems that magnesium hydrate precipitated in the pulp does not interfere, whereas magnesium carbonate is injurious. The ore was ground to 100 mesh in the presence of some oleic acid and sodium oleate. A little sodium hydroxide assisted in the cleaning treating. In some of the tests chromite as coarse as 48 mesh was floated.

It is of interest to note that acid may be used in the soap flotation of chromite. Recent tests made on a sample of California beach sands gave good results when a small amount of sulphuric acid was used after conditioning with soap. The feed was a high-intensity magnetic separator product enriched in chromite and garnet. The absence of gangue slime made possible the use of acid in both roughing and cleaning operations and flotation yielded chromite concentrates of good grade and recovery. The garnet was depressed more readily with acid than with sodium carbonate or silicate. This phase of soap flotation warrants further investigation.

The mineral in the Montana chromite is present as small crystals disseminated in a gangue of compact serpentine with minor amounts of calcite and dolomite. The chromite is lower in grade than that from California. Selected grains contained 45% of chromic oxide. The difficulties experienced with the first California sample, on account of soluble salts, were less prominent with this ore; the compact serpentine gangue exhibited a tendency to go into solution, but to a lesser degree. However, the exchange of bases was evident in flotation tests with sodium carbonate as the alkali. After a short time the pulp became unstable and flotation ceased. Caustic soda, when used in closely regulated amounts, allowed the flotation to proceed in regular fashion for a sufficient time to give the desired recovery.

Scheelite and Ferberite.—Two types of tungsten ores were examined, scheelite ($CaWO_4$) from Nevada, and ferberite ($FeWO_4$) from Colorado.

The Nevada scheelite ore was hard and had a quartz gangue. It was ground to 100 mesh. In one test the concentrate was graded up to 79% tungstic oxide. Another sample with some sulphides yielded first a sulphide concentrate and then a tungsten concentrate. The use of the sulphide flotation reagents did not interfere with the subsequent soap flotation.

In judging scheelite froths, the kind of illumination is important. Scheelite is florescent in ultra-violet rays. The florescence induced by an ultra-violet light made it easily distinguishable from quartz.

Two samples of Colorado ferberite were examined, a massive ore and a mill slime. In the first sample the mineral was so finely disseminated in quartz gangue that crushing to 200 mesh was required. The rougher concentrate was cleaned three times. Whereas alkali is requried for good roughing flotation, an excess destroys flotation. In the cleaning the usual practice was departed from by using sulphuric acid. This anomalous practice can be justified only by the results. Sulphuric acid dispersed the remaining gangue and gave a concentrate of better grade. A slight excess destroyed flotation ; the right amount gave a pulp just slightly acid. When acid is used in the cleaning some additional pine oil may be required. The technique of repeated cleaning in the laboratory is difficult because the charge is so small. A larger amount of crude ore would have to be used for better results.

Cyanite.—A good concentrate of cyanite ($Al_2O_3 \cdot SiO_2$, 63% Al_2O_3, sp. gr. 3·61) was made from an ore with clean quartz gangue. The sample was crushed to 100 mesh. Another sample with quartz, biotite, muscovite, and undetermined varieties of garnet gave more trouble. Some sulphuric acid had to be used in the cleaning to depress the biotite and garnet. The quartz and muscovite were readily eliminated in the rougher. On account of the variety or aluminous minerals the grade could not be determined by chemical analysis ; specific gravity determinations were used.

Other Minerals.—Other of the silicate minerals, such as spodumene and beryl, have been found amenable to concentration by soap flotation methods. The gangues were composed principally of quartz. Although the work is of a preliminary nature, the results are gratifying in that concentrates of fair grade can be produced. The recovery of mineral is not great ; and the slight difference in floatability existing between these silicate minerals and quartz demands a precise control of reagents if a separation is to be obtained, but tests have demonstrated the possibility of such a separation.

Conclusions.—Intermittently the study of soap flotation of non-sulphide ores has been in progress in the U.S. Bureau of Mines since 1925. In terms of number of ores, non-sulphide flotation is more important than sulphide flotation. Though incomplete, the investigation has included fourteen "ores": limestone, phosphate rock, bauxite, fluorspar, rhodochrosite, manganese oxides, barytes, siderite, chromite, scheelite, ferberite, cyanite, beryl, and spodumene. Of these, four have been put through successful trials in commercial flotation plants ; i.e. phosphate rock, fluorspar, rhodochrosite and manganese oxides. Laboratory tests indicate that some of the other ores mentioned are equally amenable.

The flotation of such ores depends on the proper selection and amounts of pine oil, sodium oleate, oleic acid, sodium carbonate, sodium hydrate, sodium silicate, and similar reagents. That sulphuric acid has to be added to this list of alkalies seems an anomaly, but repeated tests have shown that some of the ores require a little sulphuric acid in the cleaning treatment. Generally less than one hundred parts of any one of the reagents in one million parts of water is sufficient. A slight excess is likely to destroy flotation. Often the worker may be guided by phenomena instantly observable to the naked eye ; and observations throughout the work lend justification to the belief that the principles of flotation are epitomized in the "flocculation of the mineral and dispersion of the gangue."

COARSE CRUSHING AT MOUNT LYELL

A new coarse crushing section at the Mt. Lyell concentrator is described in the *Chemical Engineering and Mining Review* of Melbourne for December 5 last. It is stated that in order to cope with the larger tonnages which are now being produced by the Mt. Lyell mines, an entirely new coarse crushing section has been added to the concentrator.

The plant is situated adjacent to the mill and the railroads serving it from the North Mount Lyell tunnel have a straight lead for about one-quarter of a mile, this being especially desirable owing to night running and the occurrence of thick mists. The whole layout is an excellent example of a gravity flow, the topography of the country being very favourable. The total vertical drop from the rail level to the bottom floor of the new section is 87 ft.

Description of the Plant.—Two steel bins, each of 500 tons capacity, are commanded by two 2 ft. locomotive tracks, both lines being electrified for the electric trains from the North Lyell and Tharsis mines. The Comstock mine is served by steam trains.

The slope of the bottom of the bins reaches a maximum of 45 deg. diagonally towards the Telsmith crusher and the shape is such that the ore is drawn through doors at the corners and not at the centre. This arrangement enables the two bins to feed, by gravity, one central crusher. The size of the bin doors is 6 ft. in height and 4 ft. in width. Ross chain-feeders command the feed to the primary crusher. These are driven through worm-reduction gears cum Texropes, and run at three speeds, the normal one being 15 ft. per minute. They are operated intermittently. There are six chains in each curtain, the total weight of a curtain being five tons.

Fixed grizzlies with 3 in. spacing remove a large proportion of fines from the crusher feed. The undersize is by-passed on to the belt conveyor handling the primary breaker discharge.

Primary Breaker.—This machine is a Telsmith primary 16 in. crusher operating at a speed of 175 strokes per minute, and crushing run of mine ore to a maximum size of approximately 3½ in. The capacity of this machine at the present speed is 120–150 tons per hour. The machine is practically immune to all tramp iron, including sledge hammer heads. Its product, together with grizzly undersize, is conveyed on a short 30 in. belt conveyor to a Hum-mer screen, the ore passing under a powerful bi-polar Dings magnet which removes all the tramp iron. Nine heavy Texropes drive the crusher, the motor being 50 h.p.

Hum-mer Screen.—This machine, type 60, is fitted with two powerful vibrators (V, 64) suited for the heavy duty of the screen. The mesh of the 6 ft. by 4 ft. cloth is 2½ in. aperture, and the screen is of the full-floating type. Owing to the wet and sticky nature of the ores which are often treated,

this screen has great value and no trouble has been experienced with any packing of wet material in the succeeding crusher. The screen oversize constitutes the feed to the Symons cone crusher.

Cone Crusher.—This machine, the 5 ft. 6 in. diameter model, is direct-coupled to a 200-h.p. auto-synchronous motor. The capacity of this unit is approximately 120 tons per hour on the $\frac{3}{8}$ in. setting.

Tertiary Crushing Unit.—Two Leahy screens, each 6 ft. by 3 ft. receive the combined product from the Hum-mer screen and cone crusher. Each screen has its own motor with Texrope drive and the amplitude of the stroke on this heavy tonnage is $\frac{7}{16}$ in. The mesh of the screens is $\frac{3}{4}$ in. in the clear. A 48 in. Symons disc crusher receives the oversize from the Leahy screens, and the setting for this machine is very fine, approximating $\frac{1}{4}$ in. This machine can take the product direct from the primary crusher in the event of a shut-down on the cone crusher, the tonnage being reduced. The drive to this unit is similar to that of the Telsmith, the rating of the motor being 50 h.p.

From this point at the lowest level in the section a 30 in. by 6-ply belt conveyor, 300 ft. between centres, collects both Leahy screen undersize and Symons disc crusher discharge and elevates it equivalent to a vertical lift of 134 ft. The belt speed is 200 ft. per minute and all idlers are the anti-friction type supplied by the Link Belt Co. The power consumption on this unit is below 20 h.p. The drive is direct through the head pulley which is lagged with rubber belting, all snub pulleys being dispensed with, and a screw take-up is fitted to the tail drum. A worm reduction gear cum Texropes transmits the power from a 25 h.p. motor.

The conveyor passes through 150 ft. of tunnel, concrete-lined, and then goes into a steel gallery 9 ft. deep and 7 ft. wide to the top of the fine ore bins. The alignment of the belt is almost perfect. A walk-way 2 ft. 3 in. wide runs parallel along the conveyor. Interior painting is of Stay-White and good lighting is provided throughout. Three press buttons for emergency stopping of the conveyor are spaced along the tunnel's length. All the conveyor belts of the section were supplied by the Dunlop-Perdriau Rubber Co.

General.—All drives to the new section are either through totally-enclosed worm-reduction gear sets or through Texrope drives or a combination of both. The whole control for all motors is located on one panel on the operating platform, and all motors are stopped and started by press button control. Dust-laden air is drawn from each of the three crushers (about 1,000 cu. ft. per min. from each unit), and the plant is very free from this material. Water jets and sprays are used to recover this dust in an outside chamber.

The crew, operating on day shift only, can crush 1,000 tons, and the personnel consists of an operator in charge, a feeder on the primary breaker, and one cleaner. The total power input to the section does not exceed 200 h.p. The whole of the section is built in steel and concrete, about 196 tons of steel and 3,000 cu. yd. of concrete being employed in the building.

The San Antonio Mill.—The following description of the 150 ton mill now being built at the San Antonio Gold Mines property at Rice Lake, Manitoba, appears in the *Pre-Cambrian* for December.

The cyanide plant will have an initial capacity of 150 tons for 24 hours and the crushing plant will have a capacity of 150 tons in eight hours. The flow-sheets and design of the mill have been worked out by the General Engineering Company of Toronto and New York. The mill is being built by the company's own crew, and the site is near the No. 1 shaft, which will later be sunk to a depth of 1,000 ft., and eventually will serve as the main hoisting shaft. For the present the ore will be hoisted through the No. 2 shaft, which is approximately 1,000 ft. south of No. 2 shaft, and conveyed to the crude ore bin at the head of the mill by means of an aerial tramway.

From the crude ore bin the ore will be conveyed out by means of a 30 in. steel pan apron feeder, onto a grizzly with 3 in. openings, and thence onto a 36 in. picking belt, where it is expected that from 10% to 20% of the original tonnage can be removed as waste. The waste removed will be principally barren wall rock and will be dropped into cars placed below the picking belt and trammed to the waste dump. The milling ore remaining on the picking belt will be discharged on to a stationary grizzly with 2 in. openings, the undersize of which will drop onto a 16 in. belt conveyor and the oversize will drop into the 24-in. by 15-in. jaw crusher, the discharge of which will join the grizzly undersize on the 16 in. conveyor belt. The 16 in. belt conveyor will discharge its load onto a 3-ft. by 5-ft. vibrating screen with $\frac{1}{2}$ in. openings to remove the fines ahead of the 3 ft. Symons cone crusher. The screen oversize will drop into the 3 ft. Symons cone crusher and the discharge from this crusher will join the screen undersize in a 12 in. belt and bucket elevator, which will discharge into the fine ore mill storage bin.

From the fine ore bin the ore will be conveyed out by means of a 20-in. by 12-ft. travelling belt feeder to an 8-ft. by 5-ft. ball-mill operating in closed circuit with a 6-ft. by 23-ft. 4-in. Dorr duplex classifier. Provision will be made to take tonnage samples as the ore is discharged from the belt feeder.

In the ball-mill—classifier circuit the ore will be ground and separation made at about 2% plus 100-mesh. The classifier overflow, at about three to one dilution will be pumped into a 30-ft. by 12-ft. Dorr thickener, where the pulp will be thickened to about one to one dilution, the thickened material being sent to three 20-ft. by 18-ft. Dorr agitators, and the thickened overflow being sent to the clarifying and precipitation departments. The agitators will provide about 55 hours agitation at one to one dilution, or about 33 hours agitation at two to one dilution. If the more dilute pulp is preferable in practice, the last agitator will discharge into another 30-ft. by 12-ft. Dorr thickener, where the pulp will again be thickened to one to one dilution before being sent to the first filter. If the thicker pulp is preferable in practice, the discharge from the last agitator will be sent direct to the first filter.

The pulp will be filtered and washed with barren solution on the first American filter. The cake from the first filter will drop into a re-pulper, where barren solution will be added to bring the solution to one to one before sending it to the second American filter, where it will be filtered and washed with water. Both filters will be American disc filters and each filter will have four 8½-ft diameter discs. The cake from the second filter will drop into another re-pulper where additional water will be added to bring the dilution to one to one. The discharge from the second re-pulper will be sent to the tailings pond

in a pipe or launder and enroute the tailings sample will be taken by means of an automatic tailings sampler. The filtrate from both filters and the overflow from the second Dorr thickener will be pumped up to the mill solution storage tank, from which it will be returning to the grinding and agitation circuits.

The overflow from the first 30-ft. by 12-ft. Dorr thickener containing the gold in solution will be sent to one 10-frame 42-in. by 42-in. Merrill clarifying filter. The clarified solution will then be passed through the Crowe vacuum apparatus, where zinc dust will be added just before the solution is pumped into the 20-frame 36-in. Merrill precipitation press. From the precipitation press the barren solution will be pumped up to the barren solution storage tank, from which it will be returned to the circuit through the second Dorr thickener and the American filters. From time to time the precipitate will be removed from the precipitation press and taken to the refinery, where it will be mixed with suitable fluxes and melted in an oil-fired furnace. While in a molten state the gold bullion will be poured into cast iron moulds, each of which will contain approximately 1,000 oz. After cooling the gold bars will be shipped, weighed, packed in suitable containers and expressed to the mint.

Mining Method at Questa, New Mexico.—At the Questa mine of the Molybdenum Corporation of America, New Mexico, about 40 tons of high-grade sulphide molybdenum ore is produced per day, which is concentrated by flotation and shipped to the company's plant in Pennsylvania for the manufacture of ferromolybdenum and calcium molybdate. The mining methods used at this operation are described in Information Circular 6514, by J. B. Carman, of the United States Bureau of Mines. The mine was first worked during the War, but only a small production was made prior to 1923, when the present mill started. Total production has been about 5,000,000lb. of molybdenum sulphide.

The ore occurs in narrow veins near the margin of an alaskite porphyry which is intrusive into granodiorite porphyry. The veins are very irregular in size, shape, and distribution. The average width of ore is 12 to 18 in. The average stope is probably not over 125 ft. long and 80 ft. on the dip. The dips range from 20 to 90° from the horizontal, and average about 60°. The country near the mine is extremely rugged, so that the mine is conveniently developed by adits, on both sides of a deep gulch. Although the ground is classed as medium or soft, ground pressures are not great and not over 10% of the horizontal workings are timbered. Both hand drilling and machine drilling are used in development work and stoping. Although the former is slower and results in a higher labour cost per foot, yet the total cost is lower, because of considerable savings in explosives, pipe lines, and power. Fourteen hundred feet of hand development work cost $6.46 per ft., as compared with $7.41 for machine work. About 1 ft. of development work is necessary for every ton of ore sent to the mill.

Mining is done by open overhand stoping or by horizontal cut-and-fill stoping; the latter giving about nine-tenths of the production. Cut-and-fill stopes start directly from the drives, the fill being supported on the drive timber. Chutes are spaced about 50 ft. apart, and manways and chutes are carried up as stulled or cribbed rises as the stopes advance. Some waste must usually be broken, either to make working room or because it is included between ore streaks, but when possible it is blasted separately. The ore is very carefully screened and sorted, either in the stopes or at the surface, so that only about 40% of the material broken as ore is sent to the mill.

The ore is trammed to the surface by hand in end-dump cars holding about 1,500 lb. of ore, and is then hauled 1·2 miles down steep grades to the mill in automobile dump trucks. All underground work is done by contractors, at rates ranging from $4.00 to $5.50 per ft. for development work, and from $4.00 to $5.00 for ton for stoping. Compressed air is furnished by a Diesel engine driven compressor.

Mining costs for 1929 and 1930 averaged $11.61 per ton, of which more than half was for development work.

Gold Milling at Coniaurum.—Cyanide practice at the 500-ton mill of Coniaurum Mines, Ltd., Schumacher, Ontario, is described in Information Circular 6,541 of the United States Bureau of Mines, by J. Redington. The ore is a mixture of quartz and mineralized schist and averages about $6.00 per ton in gold. It is rather finely broken in the stopes, due to the narrowness of the veins and is dumped direct from the mine skips into a 15 ton crusher bin. Primary reduction is affected in a 10 in. gyratory crusher fed by a "live-roll" grizzly having 1¼ in. openings. The crusher discharge, minus 1¾ in. in size, is elevated to a 700-ton steel bin which affords sufficient capacity to permit alternate operation of the crusher and the rolls which follow it, thus reducing peak power loads. Secondary reduction is accomplished by primary and secondary rolls, the latter being installed in closed circuit with vibrating screens so as to handle only the oversize from the former. Screen undersize and secondary rolls discharge, minus 7/16 in. in size, are conveyed to a 1,000-ton fine ore bin. Both sets of rolls are driven at maximum rate, the setting and feed rate being controlled by the operator from ammeter readings. The first rolls are fully loaded, and the secondary set is 30% overloaded; the chief source of trouble is a rather high moisture content in the fines.

From the 1,000-ton bin the ore is laundered with cyanide solution to a duplex rake-classifier in closed circuit with a tube-mill. Classifier overflow, ground to 10% minus 65-mesh, consists of 54·5% solids, and contains 75% of the recoverable gold already in solution. Solution strength is 1·25 lb. potassium cyanide per ton, alkalinity is 0·75 lb. CaO per ton of solution, and cyanide consumption is 0·5 lb. potassium cyanide per ton of ore.

Classifier overflow is pumped to a 20 by 24 ft. agitator, from which the pulp is drawn at the bottom and raised by air-lift to a second agitator. From the last agitator the pulp is pumped to a 17 ft. bowl classifier, from which the sand is returned to the tube-mill and the overflow, averaging 60% minus 200-mesh, passes through a launder to a tray thickener. Thickened pulp is filtered and washed with barren solution on a disc filter, repulped with barren solution in a repulping tank and thence sent to an 18 by 20 ft. agitator. From this agitator the pulp goes to a second filter, where it is given a final water wash. Cake is repulped in water and piped to the tailings pond. Overflow from the thickener runs to a sand clarifier, the clear pregnant solution being thence pumped to vacuum tanks and a precipitation press. Six hundred and fifty tons of solution are precipitated

every 24 hours with a zinc dust consumption of 0·025 lb. per ton of solution. Precipitate is cleaned up monthly, washed with acid and refined in the usual manner. Recovery in 1930 was 96·35%, and operating costs averaged $0.939 per ton milled.

Erratum.—In an account of some West African lead-zinc deposits given in the last issue of the MAGAZINE it was stated that these were in Gold Coast Colony, whereas actually they are in Nigeria, the report quoted being that of the Nigerian Geological Survey for 1930-31.

SHORT NOTICES

Driving Costs.—The subject of driving costs is dealt with by M. J. Elsing in the *Engineering and Mining Journal* for January.

Skip Winding.—In *Colliery Engineering* for February, Professor G. Poole and J. T. Whetton conclude a survey of modern Continental practice in skip winding.

Mine-Shaft Equipment.—The first of a series of articles on mine shaft equipment, by Lucien Eaton, appears in the *Engineering and Mining Journal* for January.

Drilling and Blasting.—W. R. Meyers describes drilling and blasting practice at the Tilden iron-ore mine in Michigan in the *Engineering and Mining Journal* for January.

Placer Mining.—The November, 1930, issue of the *Black Hills Engineer* contains an article by F. C. Lincoln on the history of placer mining.

Tin Dredging.—A complete description of a deep-level bucket dredge designed by Messrs. F. W. Payne and Son for Killinghall Tin, Ltd., appears in *Engineering* for February 5.

Mine Gases.—D. Harrington and E. H. Denny deal with gases that occur in metal mines in Bulletin 347 of the United States Bureau of Mines.

Mine Rescue Apparatus.—In a paper read before the Institution of Mining Engineers on January 20 last, Professor Henry Briggs describes a new respiratory apparatus for use in mines.

Beryllium Determination.—F. G. Hills describes the analysis of beryllium minerals in *Industrial and Engineering Chemistry* (Analytical Edition) for January 15.

Silver in Lead Bullion.—A volumetric method for the estimation of silver in lead bullion is described by W. R. Wagstaff in *Industrial and Engineering Chemistry* (Analytical Edition) for January 15.

Ore-Microscopy.—F. F. Osborne discusses the use of plane-polarized light in the microscopic investigation of ores and metals in the *Canadian Mining and Metallurgical Bulletin* for January.

Boliden Deposits.—The ore-deposits at Boliden in North Sweden are described by O. Falkmann in *Metall und Erz* for January.

Iberian Tin Deposits.—G. Negre describes the tin deposits of the north-west of the Iberian peninsula in *Mines, Carrières, Grandes Entreprises* for January.

Tri-State Ore-Deposits.—G. M. Fowler and J. P. Lyden deal with the ore-deposits of the Tri-State District in America, in Technical Publication No. 446 of the American Institute of Mining and Metallurgical Engineers.

Lead-Zinc Ores in Dolomite.—In Technical Publication No. 442 of the American Institute of Mining and Metallurgical Engineers, M. W. Hayward and W. H. Triplett describe the occurrence of lead-zinc ores in dolomitic limestones in Northern Mexico.

Gold in Minas Geraes.—The occurrence and winning of gold in the State of Minas Geraes, Brazil, are described by G. van Collani in *Metall und Erz* for November last.

Mexican Silver Mines.—M. A. Bordeaux deals with the silver mines of Mexico in *Mines, Carrières, Grandes Entreprises* for December.

Coal Testing.—The methods and apparatus used in testing American coals are described by A. C. Fieldner, J. D. Davis, R. Thressen, E. B. Kestner, and W. A. Selvig in Bulletin 344 of the United States Bureau of Mines.

RECENT PATENTS PUBLISHED

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

15,762 of 1930 (361,903). SULPHIDE CORPORATION, Wilmington, Delaware. Ores containing iron sulphide are treated in a finely divided condition with dilute chlorinating gases, comprising nitrogen and ferric chloride as the principal chlorinating agent, in a chlorinating zone. Liberated sulphur is removed as a vapour substantially free from heavy metal chlorides.

16,763 of 1930 (362,343). SULPHIDE CORPORATION, Wilmington, Delaware. A cyclic process in which iron or other sulphides are treated dry, at elevated temperatures, by gaseous chlorinating mixtures.

24,687 of 1930 (361,324). AUGER AND BORING MACHINERY CO., LTD., San Francisco. Improved earth-boring apparatus.

25,436 of 1930 (361,957). HIRSCH KUPFER-UND MESSINGWERKE A.G., Messingwerk, Germany. A continuous process, in which magnesium is produced from magnesium oxide by reduction with metals having a high melting-point, the metallic oxides being subsequently reduced for further use in the process.

26,114 of 1930 (362,927). MINERALS SEPARATION, LTD., London, and C. H. KELLER, San Francisco. A froth flotation process in which an important reagent is a xanthic derivate of a five-membered ring compound, wherein the ring is formed by four carbon atoms and one non-carbon atom.

26,115 of 1930 (362,366). MINERALS SEPARATION, LTD., London, and W. TROTTER and E. W. WILKINSON, California. Flotation operations are carried out in the presence of an agent whose molecules consist of two hydrocarbon radicals each directly united to a sulphur atom and the said sulphur atoms united to each other to form a molecule of disulphide.

26,288 of 1930 (362,961). R. J. LEMMON and IMPERIAL CHEMICAL INDUSTRIES, LTD., London. The froth flotation treatment of oxidized ores, in which the recovery of values is improved by the use of a cyanide compound, such as sodium cyanide.

34,063 of 1930 (362,127). K. G. SMIT, Holland. The separation of metals and metalliferous minerals from ore-bearing pulps by centrifugal action.

36,887 of 1930 (363,122). MINERALS SEPARATION LTD., and S. TUCKER, London. A process for the froth flotation concentration of oxidized ores, which is characterized by the conjoint employment as

agents of di-thio-carbamates and fatty acids, or alkali derivatives thereof.

38,886 of 1930 (363,146). I. G. FARBENINDUSTRIE A.G., Frankfort-on-Main, Germany. Improvements in the manufacture and production of metals from metal carbonyls.

21,193 of 1931 (362,337). METALLGESELLSCHAFT A.G., Frankfort-on-Main, Germany. Improved electrodes for use in precipitating suspended particles from gases.

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.

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

Handbuch der Geophysik, Band I, Lieferung 1. Edited by Professor DR. B. GUTENBERG. Paper covers, 308 pages, illustrated. Subscription price RM. 36. Berlin: Gebüder Borntraeger.

Hydrogen Ions. By DR. H. T. S. BRITTON. Cloth, octavo, 589 pages, illustrated. Price 25s. London: Chapman and Hall.

Oil-Well Completion and Operation. By H. C. GEORGE. Cloth, octavo, 234 pages, illustrated. Price $3·00. Oklahoma: University Press.

The Microscopic Character of Artificial Inorganic Solid Substances or Artificial Minerals. Second edition. By A. N. WINCHELL. Cloth, octavo, 403 pages, illustrated. Price 31s. New York: John Wiley and Sons.

The Rand Gold Mines. Second edition. By E. STURZENEGGER. Cloth, octavo, 173 pages, illustrated. Price 10s. 6d. London.

China-Clay (Kaolin). The Mineral Industry of the British Empire and Foreign Countries (Imperial Institute) Series. Paper covers, 100 pages. Price 1s. 6d. London: H.M. Stationery Office.

The Combustion of Coal Dust. By A. L. GODBERT and R. V. WHEELER. Safety in Mines Research Board Paper No. 73. Paper covers, 21 pages, illustrated. Price 9d. London: H.M. Stationery Office.

Canada: Department of Mines Investigations of Mineral Resources and the Mining Industry, 1930. Paper covers, 82 pages, illustrated. Ottawa: Department of Mines.

New Geological Map of India. 8 Sheets, Scale 1 in. = 32 miles. Price 27s. London: High Commissioner for India.

Alaska: Mineral Industry in 1930. By P. S. SMITH. United States Geological Survey Bulletin 836-A. Paper covers, pp. 1-115. Price 20 cents. Bulletin 836-B, Notes on the Geography and Geology of Lituya Bay. By J. B. Mertie. Paper covers, pp. 117-135. Price 5 cents. Washington: Superintendent of Documents.

Glaciation in Alaska. By S. R. CAPPS. United States Geological Survey Professional Paper 170 A. Quarto, paper covers, pp. 1-8, with maps. Price 15 cents. Washington: Superintendent of Documents.

American Mining Law. Third edition. By A. H. RICKETS. Cloth, octavo, 811 pages. Division of Mines, State of California, Bulletin No. 98. San Francisco: Division of Mines.

Mineral Resources of the United States, 1930. Part I, pp. 25-30, Arsenic, Bismuth, Selenium, and Tellurium. By V. C. HEIKES; pp. 57-98, Iron Ore, Pig Iron, and Steel, by H. W. DAVIS; pp. 99-112, Platinum and Allied Metals, by A. W. DAVIS; pp. 113-131, Lead and Zinc Pigments, by E. W. PEHRSON. Part II, pp. 117-135, Sulphur and Pyrites, by R. H. RIDGWAY; pp. 137-149, Felspar, by H. H. HUGHES and J. MIDDLETON; pp. 151-169, Abrasive Minerals, by P. HATMAKER and A. E. DAVIS; pp. 171-180, Clay, by J. MIDDLETON and K. V. HERLIHY. Washington: Superintendent of Documents.

COMPANY REPORTS

Fresnillo.—This company was formed in 1910 to operate silver, lead, and zinc properties in the State of Zacatecas, Mexico. The report for the year ended June 30 last shows that the cyanide mill treated 764,490 dry tons of oxide ore and 15,710 dry tons of Santa Ana tailings, the whole averaging 0·12 dwt. gold and 5·34 oz. silver per ton. The bullion recovered contained 3,624 oz. of gold and 2,831,811 oz. silver, the recovery being equal to 69·7%. In addition, the concentrator treated 251,216 dry tons of sulphide ore averaging 0·28 dwt. gold, 9·29 oz. silver, 9·1% lead, 11% zinc, and 0·53% copper, producing 38,350 tons of lead concentrates, averaging 58·1% lead, 40,609 tons of zinc concentrates, averaging 52·1% zinc, and 513 tons of iron concentrate. On May 1 of the year under review the milling rate was reduced by 15% to conform with the lead cartel agreement. The total operating profit at the Fresnillo mine was $95,854, the net gain for the year, after making various allowances, being $37,110, which increased the surplus brought in to $259,793. The ore reserves at the end of the financial year were estimated to include 781,531 tons of oxide ore, averaging 0·13 dwt. gold and 5·66 oz. silver per ton, 189,044 tons of Santa Ana tailings, averaging 0·34 dwt. gold and 4·58 oz. silver per ton, 937,440 tons of positive sulphide ore, averaging 0·3 dwt. gold, 9·6 oz. silver, 8·6% lead, 9·3% zinc, and 0·7% copper, as well as 448,260 tons of probable sulphide ore, averaging 0·3 dwt. gold, 8·1 oz. silver, 8·9% lead, 9·1% zinc, and 0·5% copper. A certain amount of old patio tailings were profitably treated by the Compañia Minera de San José, S.A.

San Francisco Mines of Mexico.—Formed in 1913 this company acquired a group of silver, gold, lead, and zinc mines in the State of Chihuahua, Mexico. In view of operating losses incurred during 1931, production of zinc concentrates was discontinued at the end of October of that year, and all production was suspended at the end of December. The report for the year to September 30 last shows that the mill treated 393,390 dry metric tons of sulphide ore, averaging 0·829 grm. gold, 189·1 grm. silver, 7·3% lead, 9·01% zinc, and 0·66% copper, producing 45,727 tons of lead concentrates, averaging 4·19 grm. gold, 11·80 grm. silver, 58·82% lead, 11·97% zinc, and 3·47% copper, as well as 47,088 tons of zinc concentrate, averaging 1·047 grm. gold, 228 grm. silver, 1·64% lead, 55·27% zinc, and 1·41% copper. The operating profit for the year amounted to £60,895, but, after making various allowances, there is a net loss of £19,033, which reduces the credit balance brought in to £163,620. The ore reserves at the end of the financial year

were estimated to amount to 1,837,270 tons fully blocked and 483,670 tons partly blocked.

Mount Elliott.—This company was formed in 1907 and owns copper properties in North Queensland. In 1929 an interest was acquired in the South American Copper company. The report for the year ended June 30 last shows that the ore production by tributors on the Queensland properties amounted to 6,248 tons, assaying 23% copper, which realized £27,061, the royalties to the company amounting to £4,672. The sale of lands, plant, and stores realized £2,857. The cost of upkeep at Cloncurry over the period was £4,780. Of the 1,000,000 new shares of 2s. in South American Copper, which the Mt. Elliott company had undertaken to take at par 500,000 shares were applied for and allotted during the year.

Malaya Consolidated.—This company, formed in the Straits Settlements in 1926, works alluvial tin property in the State of Perak, F.M.S. The report for the year ended September 30, 1931, shows that 2,205,256 cu. yd. of ground was dredged, 8,070 [illegible] tin ore being recovered, the product realizing $336,190. Operating expenses amounted to 13·16 cents per cu. yd., as against 17·01 cents in the previous year. The working profit for the period under review was $21,419, but, after making various allowances, there remained a net loss for the year of $155,660, increasing the debit balance brought in to $232,362.

Penawat (Malaya).—This company was formed in the Straits Settlements in 1927 and works alluvial tin property in the State of Perak, F.M.S. The report for the year ended August 31 last shows that the two dredges excavated 2,678,600 cu. yd. of ground for a recovery of 13,829 piculs of tin ore, which realized $572,859. Operating expenses amounted to 12·517 cents per cu. yd., as compared with 19·137 cents in the previous year. In view of restriction arrangements, the company's quota has been grouped with that of Malaya Consolidated. The year's operations show a working profit of $157,740, as against £272,750 in the previous year, the net profit being $44,471, against $139,661. The carry forward is thus increased to $49,710.

Rambutan.—This company was formed in 1905 to work alluvial tin properties in the State of Perak, F.M.S. The report for the year to June 30, 1931, shows that 685,000 cu. yd. of ground was treated, 115·86 tons of tin ore being recovered, worth £7,574. Working costs amounted to £7,673 and, after allowing £1,200 for depreciation on the pipe line and accounting for various other items, there was a net loss for the year of £1,859, decreasing the carry forward to £5,862.

Sungei Way.—Formed in 1924 in the F.M.S., this company works alluvial tin property in the State of Selangor. The report to June 30 last shows that 3,796,245 cu. yd. of ground was treated, 1,119 tons of tin ore being recovered, worth £71,525, after making tribute allowance. Total mine costs for the period were £56,722, the working profit being £14,803. The net profit for the year was $4,965, which increases the amount to be carried forward to $58,419. To comply with restriction arrangements No. 3 dredge has been stopped.

Rantau Tin Dredging.—This company was formed in the Straits Settlements in 1925, to work alluvial tin properties in the State of Negri Sembilan. The report for the year to July 31 last shows that operations were conducted at a loss of $28,367, the adverse balance at profit and loss being now $14,680. Since the closing of the accounts, the Associated Prospecting Co. of Malaya has ceased active operations for the time being.

Malayan Tinfields.—This company was formed in 1925 to acquire and deal with tin-mining properties in the F.M.S. and Siam. The report for the year ended June 30 last shows the profit for the year to have been £369, which, added to the balance of £6,560 brought in, gave an available total of £6 929. A sum of £7,503 has been written off for depreciation a debit balance of £574 being carried forward.

Jos Tin Area.—This company was formed in 1910 and owns the rights over alluvial tin-bearing properties in Northern Nigeria. The report for the year ended July 31 last shows that the output of tin concentrates was 225 tons, as compared with 271¾ tons in the previous year, the price realized amounting to £80 3s. 7d. per ton, against £95 8s. 2d. the year before. The accounts show a profit for the year of £5,959, to which must be added the balance of £3,879 brought in. After making various allowances, there remained a sum of £6,979 from which a dividend equal to 5% absorbed £3,750, leaving £3,229 to be carried forward.

Offin River Gold.—This company was formed in 1900 to acquire gold mining properties in Gold Coast Colony, but it is now devoting its attention to alluvial tin-mining in Northern Nigeria. The report for the year to December 31, 1930, shows that the output of tin concentrates amounted to 75½ tons of a gross value of £7,130. The year's operations resulted in a loss of £1,551, increasing the debit balance brought in to £37,823.

DIVIDENDS DECLARED

British South Africa Company.—9d., less tax, payable Mar. 7.

Broken Hill South. 1s., less tax, payable April 15.

Changkat Tin.—6d., less tax, payable Jan. 30.

Consolidated African Selection Trust.—6d., less tax, payable Feb. 4.

Consolidated Tin Smelters.—Pref. 3½%, less tax, payable Feb. 10.

Electrolytic Zinc.—Pref. 4%, less tax, payable April 14.

Jos Tin.—3d., less tax, payable Jan. 23.

NEW COMPANIES REGISTERED

Calloy.—Registered as a private company. Capital: £10,000 in £1 shares. Objects: To acquire certain rights in processes and methods for the preparation of the alkaline earth metals and/or the alkali metals, the preparation and refining of metals and alloys, and the recovery of possible by-products by the utilization of the alkaline earth metals and/or alkali metals, and the preparation of other metals and alloys from their carbides, silicides, phosphates, hydrides, nitrides, and similar metastable compounds, etc., and to adopt agreements with G. N. Kirsebom and the National Smelting Co., Ltd. Directors: G. N. Kirsebom, F. Kirsebom, S. Robson, and L. B. Robinson.

Mapeke Mines.—Registered January 20. Capital: £92,000 in 5s. shares. Objects: The purchase of the undertaking and assets of Mapeke Asbestos Mines (in liquidation). Directors: Mr. N. C. Stoneham, Comdr. H. B. Pilcher, and Mr. M. Desmond. Office: 6, Broad Street Place, E.C. 2.