The Mining Magazine

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EDITORIAL

THE Annual Dinner of the Institution of Mining and Metallurgy is to be held at the Hotel Victoria on Wednesday, April 22, when the chair will be taken by the President, Mr. J. G. Lawn.

A NEW book—"Surveying Calculations," by Frederick Winiberg and published by Mining Publications, Ltd., the proprietors of THE MINING MAGAZINE—makes its appearance this month. It should prove a useful companion volume to "Metalliferous Mine Surveying," by the same author, who is lecturer in this subject at the Camborne School of Mines.

IN February last reference was made to the centenary of the St. John del Rey and it is of interest to be able now to add that the Prince of Wales, in the course of his tour in South America, visited the mine this month and descended to the deepest level. As the Duke of Cornwall the Prince not unnaturally takes an interest in lode mining and he is, of course, an Honorary Member of the Institution.

A NEW edition of that useful reference work the Royal School of Mines Register of Old Students is in course of preparation and we have been asked to mention this with a view to encouraging old students whose present whereabouts are unknown to communicate to Professor Truscott those particulars about themselves which are called for in the Register, such as their present address and occupation and a record of their career since graduation.

ANOTHER link has been forged in the chain of African railway communications by the completion of the line extending the Benguela Railway from the Angola frontier to Tenke (or Tshilongo, as it has been called in earlier references in the MAGAZINE), on the Katanga railway. When this line is formally opened in July next the most important step in connecting the copper fields of the Katanga and Northern Rhodesia with the shortest route to Europe will have been accomplished.

LAST month—synchronizing with the date of the March issue of the MAGAZINE—saw the opening at Buenos Aires of the first British trade exhibition to be held outside these islands. In these times of depression and almost universal pessimism this can surely be regarded as a token of confidence in the future ability of our factories to meet the requirements of foreign customers. It is equally encouraging to note that many manufacturers of plant of interest to mining men are among the exhibitors, as may be seen from the notes elsewhere in this issue and to which reference was also made last month.

IN connexion with the exhibition of mineral resources which continues at the Imperial Institute until the end of this month and to which extended reference was made in our last issue a series of addresses have been delivered by those competent to deal with the mineral wealth of different parts of the Empire. One such address by Sir Edwin Pascoe, Director of the Geological Survey of India since 1921, called attention to the incomplete exploitation of the mineral resources of that country. Needless to say he was referring to the non-metallic minerals and was urging the desirability of setting up local industries for the manufacture of various articles at present imported by the Empire which might without any difficulty be made from indigenous raw materials. It is of interest also to record, in connexion with this exhibition, the munificent gift which has been lately made of £36,000 to be applied to the maintenance and improvement of the Imperial Institute. This is surely evidence of the increasing public appreciation of the undoubtedly valuable services which the Institute performs for the community, to the lack of which in certain respects reference was made last month.

Applied Geophysics

The interpretation of geological structure, particularly during the last decade, has become of interest to a much greater body of men than the pure geologists, mainly owing to the scientific development of several new methods of exploration. Aeroplane surveys of remote regions require the assistance of aircraft manufacturers, skilled aviators, and

photographers; bore-hole surveys demand the intelligent co-operation of the instrument maker and driller; subsurface water analysis brings in chemical co-operation, and, lastly, geophysical methods of subsurface exploration are only correctly applicable by the combined work of physicists, instrument makers, and field geologists. The MAGAZINE has in the past always shown a willingness to publish the results of geophysical survey methods, holding the view that only by correlation of results in all parts of the world and under all conditions could these methods be quickly developed so as to be of use in scientific prospecting for minerals. That this quick dissemination of results could only benefit those anxious to exploit the new science was quickly grasped and last summer witnessed the fourth general assembly of the International Union of Geodesy and Geophysics, this being held in Stockholm. This has been followed by an exhibition, recently opened in the Science Museum, South Kensington, of apparatus and equipment used in geophysical surveys. The exhibits have been selected to illustrate the development of all the important methods at present employed in the location of mineral deposits by the use of sensitive physical apparatus, as well as the evolution of the instruments themselves. Details of field operations and the technique of the various methods are also represented, while in addition many examples are shown of results obtained by geophysical surveys in various parts of the world. At the same time a booklet[1] has been issued by the Science Museum which briefly examines the development of the geophysical investigation of subsurface structure and anomalies before describing the exhibits in the Museum.

The various geophysical methods which have been used, or are in process of development, for the discovery of mineral deposits depend upon the ability of the particular method to recognize the difference in physical properties between the deposit and the enclosing rocks. The four physical properties which have been chiefly examined are those of magnetic susceptibility, density, electrical conductivity, and elasticity, although attempts have also been made to make use of radioactivity and to interpret geothermal gradients in relation to structure. From the properties investigated the methods have been designated the magnetometric, the gravimetric, the electric, and the seismographic, and it has been pointed out that they fall naturally into two groups. The first comprises those which, like the gravimetric and magnetometric, measure effects of physical irregularities at a distance, while the second, which includes the seismographic and the electric methods, measures the effects of the stimulus of applied energy. It is emphasized by the authors of the booklet mentioned—and we can endorse their view—that in order that practical geophysics may be of the fullest use it should when applied to specific problems be aided by all the known geological and mining information, in order that the most suitable method for attacking the particular problem may be chosen. In no case can it profit to pit geologist against geophysicist; rather should they work in the closest collaboration, using the geophysical information to interpret doubtful structures and to choose favourable drilling sites.

Such an exhibition as the one at the Science Museum should have a dual purpose. It should show the evolution of apparatus in such a manner that those previously unacquainted with such instruments can grasp the underlying principles which govern their use and it should give results obtained with the various methods on areas where the structure is known, so that comparison may be made and results assessed. On both these counts the present exhibition may be said to succeed and those responsible for its initiation are to be congratulated.

[1] "Applied Geophysics," by Capt. H. Shaw and others. H.M. Stationery Office. Price 2s.

The Institution Meeting

At the March meeting of the Institution the papers presented once again covered widely different subjects, the first, "The Use of Hole-Directors in Ground-Breaking Control," by Mr. H. Simon, dealing with mining practice on the Witwatersrand and the second, "The Treatment of Hollinger Precipitate to Produce Fine Gold," by Mr. Matthew Scott, covering refining practice at this well-known Canadian gold mine. The meeting was well attended and the discussion, particularly of the first-named paper, which revealed something of the vast amount of work done by the great South African mining groups in their endeavour scientifically to exploit their deposits, was extremely interesting.

That the use of hole-directors in the correct placing of blasting holes was becoming

general on the Rand mines has been known for a long time and some account of them was given in the MAGAZINE for March, 1927, by Mr. Bernard Beringer. This was amplified in December, 1928, by a digest of a series of articles appearing in a South African publication. The paper by Mr. Simon—which, in the absence of the author abroad, was introduced by Professor Truscott —shows, however, just how far their use has progressed. Full extracts from the paper, which was submitted by the author as a thesis for an engineering degree to the University of the Witwatersrand, appear elsewhere in this issue, but many aspects of the subject should be dealt with here. Particular stress is laid on the search for means of reducing working costs carried out by those in charge of the Rand mines, in order that low-grade ore at depth might be profitably dealt with, and the author postulates that, as the modern miner on that field is in many cases a descendant of farmers and has thus not inherited mining sense, it has been necessary to proceed on the basis that the man is unskilled. Here it might be pointed out, however, that the use of hole-directors need not be confined to this type of worker, the failure of the skilled miner to compete successfully with an unskilled man provided with a director being a recognized fact, as was stressed during the discussion by Mr. Edgar Pam. The main use of the director is that it enables the correct burden to be placed on each hole in order that a certain charge of explosive may give the best results. It is well known that the three factors which have to be borne in mind in ground breaking are the strength of the ground, the weight of explosive to be used, and the burden to be given to the hole—in other words, its correct direction and length. As the weight of explosive used must vary directly with the ground strength but with the square of the burden, the importance of the last factor cannot be too strongly emphasized. The hole-director, its size once determined for stoping work, or the pattern correctly adjusted for the necessary cuts in headings, enables efficient work to become usual rather than otherwise and the effect of the use of such devices on working costs can readily be anticipated. That this reduction of costs has been realized is well shown by figures given by the author in his paper, where it is stated that on the Crown Mines the total footage for a year was advanced from 62,349 in 1923 to 93,301 in 1928, while the cost per foot was reduced in the same period from 66s. 4d. to 46s. 8d., although an average cost per foot would appear to be about 51s., since the figures for 1928 cover an abnormally large amount of development. While the advantages of the hole-director are evident, the disadvantages are, perhaps, equally so. It is obvious that no use can be made of natural parting planes in the rock broken, since the drilling round is standard; that constant checking has to be done to ensure that the correct size of director is being used, particularly in stoping work, and, lastly, the directors themselves must constantly be examined in order that defective instruments shall not be used. The author considers that it has been definitely ascertained that all rock-breaking costs can be scientifically controlled and, after studying his work, it is difficult to disagree with him. Other members who took part in the discussion of this paper were the president (Mr. Lawn), Mr. Brodigan, and Dr. Cullen.

The second paper, on the refining of Hollinger precipitate, had also to be introduced in the absence of the author, the task falling to Dr. Sidney Smith. In this paper, the substance of which also appears elsewhere in this issue, details are given of the process which it had paid the management of the Hollinger mine to instal rather than to ship concentrates for refining outside. The solution of the Hollinger gold is achieved by the use of calcium cyanide and the gold and silver are subsequently precipitated by the use of zinc dust and the Crowe vacuum process. The precipitate having been filtered, zinc, lime, lead, and iron and alumina are removed by a hydrochloric acid treatment, copper and silver being subsequently removed by treatment with sulphuric acid. The gold finally shipped assays 994 to 997 fine and can be sent directly to the mint. Copper and silver are recovered from the sulphate liquors by precipitation with aluminium powder and the bulk of the lead is recovered from the chloride liquors. The cost of the process, from precipitate to metal, works out at 6·18 cents per ounce troy of gold and at 5·14 cents per ounce for gold and silver. The average cost per ounce troy, including refinery costs and mint charges, for the three years before the installation of the process was 7·87 cents, ample justification for its installation. The discussion on this paper was led by Mr. Newman, who was followed by Dr. Cullen and Mr. Lawn.

Oil from Coal

From time to time the MAGAZINE has directed attention to the subject of the treatment of coal and other carbonaceous matter for the extraction of tar oils from the point of view of its bearing on the economics of power generation and also from that of its possible ultimate influence on the oil producing industry. Opportunity is afforded for further reference to the problems involved by reason of the considerable attention which has been given to a recent public utterance by the Civil Lord of the Admiralty with regard to the Navy's fuel-oil requirements being possibly met in the not distant future by supplies obtained from coal, with which objective extensive experiments have for some time been carried out both by Government and private research organizations. Last month, in the course of a review of the position of the Empire with regard to mineral resources, the weakness of the Imperial petroleum position was pointed out, but it was also indicated that our supplies of coal and oil-shale—potential sources of liquid fuel—were enormous. The statement of the Civil Lord may therefore be taken as a sign of the progress that is being made in the direction of making this country independent of foreign oil supplies and the position is worthy of examination.

The industry formed for the recovery of oil from coal—generally known as low-temperature carbonization or, better, as low-temperature distillation—has been in this country in a somewhat difficult position. The well-known processes, it is felt, have been to a certain extent exploited by their inventors, who have endeavoured to impose royalty terms that have made economic working impossible. There are at the moment, however, signs that the industry is coming down to a sane basis. As was pointed out in the MAGAZINE for November, 1928, in the course of an article on the World Power Fuel Conference by Dr. Murray Stuart, a process of low-temperature distillation has been successfully working for some time in conjunction with the Newcastle Electric Power Company's Dunston Station, with the result that the cost of fuel under the boilers was considerably cheapened. This process, which has been much improved since that article was written, has been evolved by an engineering firm which derives no benefit from its use. Just as other machinery is sold, so this firm is supplying its plant, with a guarantee and free of all royalty claims. This implies that the industry is now freed to an extent from claims which have impeded its growth. Still one more point of advance may be noted and that lies in the development of an accessory process, which treats the oil distillates as they come from the retorts by passing them over catalysts which first desulphurize and then crack them, the result being an important increase in the more valuable light oil fractions. This process, which is of French origin, has been the subject of much recent investigation and is regarded as distinctly promising, as it may be possible by its employment to convert in this way some of the phenolic compounds into hydrocarbons, an additional economic gain. There is also another coal treatment process which, although in its early stages, is undergoing rapid development side by side with those associated with carbonization. The synthesis of oils by the hydrogenation of coal may soon prove commercially practicable and should this be the case a much higher yield of the lighter fractions is to be expected. These industries may be said to have entered a new phase and the pronouncement of the Civil Lord may be taken as a sign that they may in time be expected to alter considerably the economic position of the Empire with regard to potential oil resources. At the same time their dependence on cheap coal supplies should be emphasized and this is obviously a point which will govern the location of plants as much as the success of a particular enterprise.

In stressing the processes which deal particularly with the distillation of coal and which have three products to dispose of—coke, oils, and gas—it is as well not to forget other available natural resources of mineral oil—the cannel coals and oil shales. These substances will not, it is true, yield smokeless fuel in addition to the oil, but, as has been pointed out by Professor Briggs, we can manage without smokeless fuel, but not without oil. The extent of our resources of such minerals in this country is, perhaps, not well known, but they should not be forgotten, as some day they may be needed, and Professor Briggs' suggestion that the present is the right time for a survey of such mineral resources is worthy of serious consideration.

REVIEW OF MINING

Introduction.—Once again it has to be recorded that there is no change in the general position, which is likely to remain quiet pending the introduction of the Budget, concerning which there is the usual crop of rumours. Base metals at one time showed an improvement, but it was not maintained.

Transvaal.—The output of gold on the Rand for March was 869,331 oz. and in outside districts 41,667 oz., making a total of 910,998 oz., as compared with 839,937 oz. in February. The number of natives employed in the gold mines at the end of the month totalled 207,239, as compared with 209,777 at the end of February.

In his presidential address at the annual meeting of the Transvaal Chamber of Mines Dr. P. M. Anderson declared that the main needs of the industry in South Africa were two in number. These were, first, the assurance of adequate native labour and, secondly, some measure of relief from the handicap imposed by heavy contributions towards miners' phthisis compensation. As regards the first, Dr. Anderson urged once again the necessity of permitting recruiting in closed areas, otherwise a return to a continued shortage of native labour was inevitable. In the case of phthisis compensation, the speciousness of the argument that the existing mines were liable as successors to defunct undertakings was emphasized. Mr. Arthur French was elected president of the Chamber for the ensuing year.

Towards the middle of last month shareholders of Daggafontein Mines, Ltd., were informed that arrangements had been made with the Government for the lease of the undermining rights of 722 claims, adjoining the north-eastern boundary of the property. The company's total area is thus increased to 3,731 claims. Subsequently notice was given in a circular to shareholders that it was the intention of the company to issue 145,000 new shares at 37s. 6d. and to offer them to the present shareholders pro rata to their holdings. The issue was underwritten by the Rand Selection Corporation, Ltd., who were given the right to take up additional shares in the company to a maximum of 55,000 at a price of 45s. per share, the total issued capital being thus raised to £1,650,000.

A cablegram from the East Geduld Mines states that the shaft passed through the reef on March 31 at a depth of 2,834 ft. Sampling showed it to have a value of 26 dwt. over a width of 19 in.

During 1930 Rand Mines, Ltd., made a profit of £601,710, as against £545,470 in the previous year. The sum of £460,159 was distributed as dividends, equal to 90%, against 100%, and, after meeting tax and investment requirements, the balance of £428,817 was carried forward. The interest in Bolivia, acquired during 1929, has been adversely affected by the fall in tin and silver prices, but work on the mine on the Cerro de Potosi was gradually increased during the year, the output from December, 1929, to the end of November last being 1,565 tons of fine tin and 102,137 oz. of silver. Other interests of the company show little change.

The report of the Union Corporation for 1930 shows that the net profit for the year was £248,888, as against £418,034 in the previous year, and that, after adding £119,629 brought in, there was an available total of £368,517. The dividend distribution for the year amounted to 3s. 3d. per share, absorbing £227,500, and the balance of £111,017 was carried forward. The corporation has acquired an interest in Grootvlei Proprietary Mines, which has mineral rights over property adjoining East Geduld Mines and which has recently concluded negotiations with the Union Government for the lease of 2,500 claims. Arrangements are being made for the exploitation of the lease area and of the mining area owned by the company.

Diamonds.—A notice issued by De Beers Consolidated Mines, Ltd., states that, in pursuance of the policy of expansion which was foreshadowed at the last general meeting, the company is to acquire from the Anglo American Corporation large interests in the New Jagersfontein, the Consolidated Diamond Mines of South-West Africa, and Cape Coast Exploration. To provide funds for this purpose the company has created £2,500,000 5½% debentures, redeemable in 25 years, for which a sinking fund will be formed. Of this issue £2,414,705 will be allotted to the Anglo American Corporation, no offer being made to the general public.

Owing to the continued depression in the diamond market, the New Jagersfontein Company has announced that no dividend will be declared for the year ended March 31.

The report of Koffyfontein Mines, Ltd., for 1930 shows a profit of £41,729. Allowing for diamonds on hand at the end of the year and the balance brought in, there was an available total of £194,770 and from this £76,984 has been distributed as a dividend, equal to 25%. After making

various allowances, the balance of £29,125 has been carried forward. During the year 353,255 loads of blue ground were hauled and deposited on the floors, while 690,907 loads were taken from the floors and washed, the yield being 62,450 carats. The stock of blue ground on the floors at the end of the year was 2,343,481 loads.

Southern Rhodesia.—The output of gold from Southern Rhodesia during February was 42,818 oz., as compared with 45,677 oz. for the previous month and 43,385 oz. for February, 1930. Other outputs for February were: Silver, 5,468 oz.; copper, 77 tons; coal, 54,728 tons; chrome ore, 8,669 tons; asbestos, 4,720 tons; mica, 7 tons.

During 1930 Rezende Mines made a working profit of £63,523, as compared with £63,080 the previous year. After making provision for income tax, depreciation, and other expenses and adding the balance of £4,027 brought in from the previous year there remained an available total of £46,279, from which £39,375 was distributed as dividends, the balance of £6,454 being carried forward. During the period under review 76,400 tons of ore was milled at a cost of 24s. 9d. per ton. The ore reserves at the end of December last were estimated at 165,000 tons averaging 9·6 dwt., as against 184,000 tons averaging 8·8 dwt. at the end of the previous year. In July last a larger interest was acquired by the company in the Reliance and Monarch options, where development work is in progress.

Shareholders in Shamva Mines, Ltd., which went into liquidation last year, have received a sum of 6·6d. per share as the first distribution. A circular from the liquidator announces that some machinery and plant has been disposed of, but that the major portion remains unsold. Revenue is now being received from the Asp mine, which was let on tribute prior to the liquidation, and negotiations are in hand for letting the Shamva mine in the same way.

Northern Rhodesia.—An announcement made last month that mining operations at the Broken Hill mine had been suspended and that staff retrenchments would be made was followed by a notice from the company which stated that they had ample ore supplies on the dumps to maintain plant operations and that zinc and vanadium production would be continued.

Gold Coast.—A circular to shareholders of the Consolidated African Selection Trust issued this month states that it has now been found possible to amalgamate the business of the company with that of its two subsidiaries, African Selection Trust, Ltd., and Anglo African Exploration, Ltd., owing to the fact that the Executive Council of the colony has now authorized the Consolidated company to hold all the concessions. The two subsidiary companies have accordingly gone into liquidation, arrangements protecting debenture holders having been previously made.

Australia.—At a meeting of debenture holders of Mount Isa Mines, Ltd., held last month, the necessary alteration in the trust deed was sanctioned which has permitted the company to increase its capital to £3,666,667 by the creation of 666,667 ordinary £1 shares. Accordingly it has been decided to create and offer to debenture and share holders £666,667 (Australian currency) 6% convertible second debenture stock, subscriptions in London to be made at the fixed rate of £100 sterling for £133·3 Australian. The stock carries option rights and the proceeds of the issue are to be used to bring the mines to the production stage. In the circular it is stated that the postponement of operations has been mainly due to water troubles, which have prevented the completion of the main haulage drive and of the loading pocket at the shaft. Pumps of sufficient capacity to cope with all the water encountered have now been installed.

A circular to shareholders of Lake View and Star, Ltd., announces the receipt of a report on the property by Mr. C. O. Lindberg, who has made an examination on behalf of the New Consolidated Gold Fields, Ltd. As a result, instructions have been given to proceed immediately with the increase of the treatment plant capacity to 30,000 tons and ultimately to 40,000 tons per month. Arrangements have been made with New Consolidated Gold Fields to provide the necessary funds for the purchase of plant. Regarding the reduction in the basic wage for miners, which was mentioned in these columns last month, it has been announced that no change will be made by either the Lake View or Wiluna companies.

India.—The report of the Mysore company for 1930 shows a profit of £127,071, as against £130,710 in the previous year, and dividends equal to 1s. 3d. per share were paid. The ore treated totalled 190,829 tons, from which 99,438 oz. of gold was recovered. In addition 2,466 oz. was recovered from other sources. The reserves

of ore at the end of the year were estimated to be 471,418 tons, which is 45,606 tons less than at the end of the previous year. Exploration work at depth is having favourable results, but work on the pilot shaft east of the main workings has not resulted in any discovery of importance.

During 1930 the Champion Reef treated 91,545 tons of ore, recovering 52,728 oz. of gold. In addition 9,932 oz. was recovered from other sources. Sales of bullion realized £265,540 and the profit for the year was £42,579. The payment of a dividend of 1s. per share absorbed £26,520 and, after making various allowances, the balance of £4,109 was carried forward. The ore reserves at the end of 1930 at 229,127 tons show a decrease of 48,959 tons when compared with the previous year.

During 1930 Balaghât Gold Mines, Ltd., treated 39,200 tons of ore, recovering 22,256 oz. of gold, while 180 oz. was recovered from the treatment of slags. The value of the bullion returned was £94,941, a decrease of £43,375 when compared with the previous year, there being in the year under review a loss on revenue account of £6,797. Under these circumstances, largely due to the strike in April last, it was impossible to declare a dividend on either the preference or ordinary shares, as has been previously announced. The reserves of ore in the mine at the end of the year were estimated to be 41,523 tons, showing a decrease of 14,485 tons. Developments on the 48th level North and on the 51st level have been favourable, however, and it is stated that there are prospects of opening up a new ore-body in this section of the mine.

During 1930 the Central Provinces Manganese Ore Company made a trading profit of £258,211, as against £306,135 the previous year. Dividends equal to 17½% were paid, against 22½%, and, after making various allowances and placing £8,093 to reserve, the balance of £45,325 was carried forward.

Panama.—A meeting of the Panama Corporation which was to have been held last month, but which was postponed owing to certain legal difficulties, was called for the purpose of resolving that the capital of the corporation should be increased to £4,500,000 by the creation of 2,500,000 new shares of £1 each. The main purpose of the increase in capital was to provide for the absorption of all subsidiary companies by the parent corporation. The meeting is now to be held on Friday next. Meanwhile it has been announced that production has commenced on the El Mineral alluvial area.

Yugoslavia. — Trepca Mines, Ltd., announced last month that the deep adit had entered ore at 2,524 metres. Later advice is to the effect that the adit has passed through 184 ft. of ore of good grade and that the face is still in ore.

Spain.—The report of the Rio Tinto Company for 1930 shows a trading profit of £1,070,400, against £1,669,782 the previous year. The total income was £1,141,692, against £1,930,110, and £506,250 was distributed as dividends, equal to 20s. on each ordinary share, the balance carried forward being £384,367.

Cornwall.—The report of East Pool and Agar, Ltd., for 1930 shows that 900 tons of black tin was produced during the year, as compared with 1,029 tons in 1929. The price realized per ton fell from £122 to £90. The output of refined arsenic was 330 tons. The ore treated amounted to 77,653 tons, of which 63,948 tons came from the Rogers lode. Economies effected during the year reduced the expenditure to £95,974 from £122,711, but the year's working resulted nevertheless in a loss of £10,839, which leaves the debit balance of £10,176. Since October last work has been restricted at the mine to one shift per day.

Consolidated Mines Selection Company.—The accounts of the Consolidated Mines Selection Company, Ltd., for 1930 reflect the acute depression which prevailed during the year. No less than £104,630 has had to be written off to allow for share depreciation and it has been necessary to transfer £100,000 from the reserve account to profit and loss as well as £10,000 from the dividend equalization account. The balance carried forward was £2,928.

Tin.—The acceptance of the tin restriction scheme by 68 per cent. of the Malayan producers had a favourable effect when the announcement was made, but there has since been a reaction, the enormous "visible supplies" continuing to threaten the industry. The International Committee which will regulate the production and export of the metal held its first meeting this month, resolving to ask the governments of Burma, Siam, and other countries to adhere to the scheme. The next meeting of the Committee is to be held next month at the Hague.

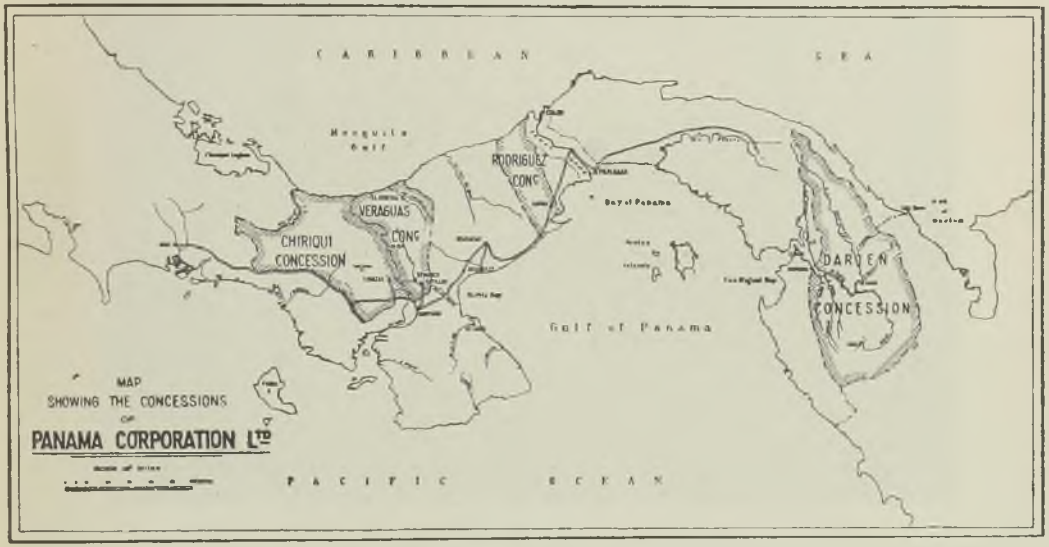
PANAMA

By V. F. STANLEY LOW, M.I.M.M.

The author, who is consulting engineer to the Panama Corporation, gives an account of progress in the corporation's concessions, dealing particularly with the alluvial discoveries. In a subsequent article he hopes to cover the lode mining.

In the article which appeared in the October and November, 1928, issues of the MAGAZINE but very brief reference was made to the Panama Corporation and its concessions. The corporation has, however, become such an important factor in Panamanian life and has done so much to open up and develop the country that a description of the areas granted to the corporation and an outline of the work in hand should be of interest.

I do not propose to write a long technical description of the cyanide plant and the two hydraulicking plants which will be in operation when this appears in print, but rather to give a general description of the country as it has appeared to me on my various tours of inspection.



MAP SHOWING THE CONCESSIONS OF PANAMA CORPORATION Ltd

With, perhaps, the exception of J. M. Henderson, the corporation's geologist, I think I may safely state that I have travelled over more of the country covered by the concessions than anyone else in the corporation's employ and it has been a matter of much interest to me to observe how quickly transport and commissariat conditions can be made to improve, following the formation of base camps and established centres for prospecting and development work. Matters are vastly different to-day in Darien from what they were four years ago when I tramped with Alan Gibb for eight days through the hitherto unexplored river forests to the source of the Tuquesa River. Alan Gibb, who did such excellent cartography of the previously unknown country in Darien, and Daniel Gibson, who was the pioneer of Banka drilling, then underwent more hardships than members of our staff in that concession are now called upon to undergo. In those days travelling was done in small, slow, open, hand-propelled canoes, whereas there are now the advantages and comfort of a fast Thornycroft launch and larger canoes propelled by outboard motors. Many of the canoes are fitted with awnings, so that there is no longer any necessity for sitting in the blazing sun or the pouring rain for hours on end without protection whilst traversing the rivers of Darien. Yet it seems strange that during my recently-completed trip to Darien I should have, in a comparatively short campaign, encountered a series of mishaps which more than equalled the sum of the accidents which had occurred to me in all my previous excursions. C. J. Inder was with me during part of my vicissitudes, which include the following :—Twice having my clothes and bedding thoroughly soaked at night through rain leaking through the camp roof ; canoe overturned in the rapids and carried a quarter mile down stream ; launch sinking at anchor when I was asleep ; launch holed by submerged log two days later and in sinking condition ;

horse falling with me on bridge ; when crossing a stream and in comfortably dry condition falling into the water up to my neck. I should also add that a canoe I sent back to the base for food supplies sank in rough water on the way and lost some of our material. The worst of all these was the upsetting of the canoe, through faulty work of our crew, when coming down a flooded river. I lost all my property—camera, field-glasses, notebooks, and clothes. Inder nearly lost his life. All material other than mine was recovered. There certainly was a Jonah somewhere in that canoe.

On the Atlantic coast camps, as well as at the Remance and Hatillos mines, living has become easier and comfort has improved. El Mineral, which is about 11 miles inland from the Atlantic Ocean, can now be reached from the coast by boat and mule or from the interior by mule, via Santa Fé. When I made my first visit to El Mineral—or Cucullo, as it was then called—there was only a rough foot-track across country and, as the little rock-protected landing place—Portete—on the Atlantic coast had not then been discovered, there was every possibility that the traveller from Colon by the Carribean Sea, unless the weather was fairly mild, would not be able to land. On the occasion of which I speak I started from Remance by mule and made Santa Fé. The distance from Santa Fé to El Mineral is now about 24 miles by the mule track which we have constructed. This rises to an altitude of 4,500 ft. at the summit and falls to 650 ft. at Cucullo. Nowadays the journey can be done comfortably in a day and a half in fine weather, but in former days the mules carried one only for about 10 miles from Santa Fé and then it was foot—and often foot-and-hand—work for the rest of the journey. The first almost vertical rise of 2,000 ft. in a comparatively short horizontal distance through mud, slush, and rain to the first night camp left much to be desired, and it is strange how cold one can become when wet through with rain and sweat if one tarries by the roadside, even for a few minutes, although the thermometer may never drop below 70° Fahr.

Electric Power-House at Calamacito for the Remance Mine.

" Keep on walking " is a good old slogan for the pedestrian in those altitudes unless he is looking for early trouble. As the sea was favourable I returned by boat to Colon, the journey taking about 18 hours. Travelling speed is faster to-day and under good conditions the sea journey can be completed in about 12 hours.

A similar improvement has been made in the road-making and surfacing of the main highway forming part of the road which it has been agreed between the several republics of North and South America will be constructed, with the various sections linked together, so as to form a continuous thoroughfare from Canada to Patagonia. Four years ago it took me an hour and a half to go a quarter of a mile along this road after a rain storm. The surface of the road

was then of andesitic clay and faulty skid chains in my car prevented any but the slowest progress. The whole of that road from Panama City to Santiago—168 miles—and far beyond, has now been formed and surfaced with crude oil composition and it was only in December last that I was held up by a " speed cop " on a motor cycle for exceeding the speed limit over the plains on the more open part of the road. I was certainly doing something over 55 miles an hour, but, as there was no one in sight ahead, a straight road, and good visibility, I presume I was arrested for my own supposed safety. I need only add that both the car and the road were perfectly safe for a higher speed than that at which I was travelling.

Portage on the Conception River: Veraguas Concession.

Santiago is the base town for both the Remance and Hatillos mines and, except during the worst part of the rainy season, both these mines can be reached from it by motor car. Each mine is about 18 miles distant from Santiago and can be reached by caterpillar tractor when the road is not negotiable by ordinary car. Santiago, the capital of Veraguas, was a notable town during the Spanish occupation and even up to comparatively recent times. The two oldest churches in the whole of the great American continent stand to-day in Santiago and San Francisco, which is some 12 miles distant on the way to Hatillos.

The Panama Corporation owns four different concessions in the isthmus:—Darien, Veraguas, Chiriqui, and Rodriguez. The first three of these concessions were granted to the corporation by the Republic of Panama, the fourth was obtained by purchase from a private owner. They have an aggregate area of 7,150 square miles and embody the right to a title of perpetual ownership to be granted by the Government of Panama in respect of each mine discovered and selected, free of payment, except a royalty of 2 per cent. on the gross receipts from the sale of gold extracted. Perpetual exemption is granted from all national and municipal taxes on the export of mineral products and on the import of machinery and materials and other necessities of a mining undertaking.

The Darien concession lies to the east, towards the Colombian border. It is in heavily-watered and thickly-timbered country, much of it flat, but a great deal consisting of highlands and precipitous mountains. It was down the River Chucunaque that the British pirates are said to have travelled and then up the Tuyra River to raid the Holy Ghost mine at Cana. At the beginning of the 18th century this was the most notable gold mine in the world. There is an old Spanish fort still standing at Yavisa. Records in existence at Bogota show that at least three notorious raids were made on this mine by our pirates, who stole all the gold available, worked the mine until it became unsafe, and then left it for the Spaniards to put in order again.

THE AUTHOR, AT A BALSA RIVER CAMP.

After the third and final recorded raid the mine fell in—the Indians at the time were rising in revolt—and was abandoned. I believe I am right in saying that from that date until the end of last century, when Ernest Woakes discovered three wooden treadmills underground in a state of perfect preservation, the mine had remained covered up and of unknown location. The Holy Ghost mine was so rich and there was so much alluvial gold being won from the Darien rivers that the Court of Spain issued a decree closing all mines and alluvial river workings because the amount of gold being won attracted the British buccaneers and caused pillage and bloodshed.

The rivers of Darien are to-day carrying alluvial gold as they did in old Spanish times and I can safely say that nowhere in my wide mining experience have I seen alluvial gold so widely distributed. I do not say that every river carries gold, for we know of several rivers where this does not obtain, but in the majority of rivers an expert with a pan can get very encouraging prospects. It is, of course, our object to discover any payable reef from which this gold has been shed and, if possible, to locate gravel beds in which sufficient gold has segregated to be economically exploitable.

The Cana plateau on which the old Holy Ghost mine is situated is some 2,000 ft. above sea level. An Anglo-French company worked the various mines on this plateau for some time and extracted quite a large amount of gold. The company constructed a railway line from the Tuyra River to the plateau—a distance of some 20 miles—and erected two or three milling plants and many buildings for the accommodation of the staff and workmen. Hydro-electric plants were in commission.

On the flat below the Holy Ghost mine and the San Jose hill the Anglo-French company put down several bores which showed attractive values. We have also bored this flat and part also of the San Jose hill. There has been a cessation of work here for the duration of the rainy season, but such tests as have been made of the auriferous alluvium tend to show that, on account of the mud which exists and the very fine and leaf-like nature of the gold, some efficient and economical system of extraction will be required if the treatment of the material is to be profitably carried out. The San Jose hill, which abuts on this flat, was partly worked by the Anglo-French company. This is a low-grade proposition which promises to run into large tonnages, but here again some economical method of mining and treatment will have to be adopted if success is to be attained.

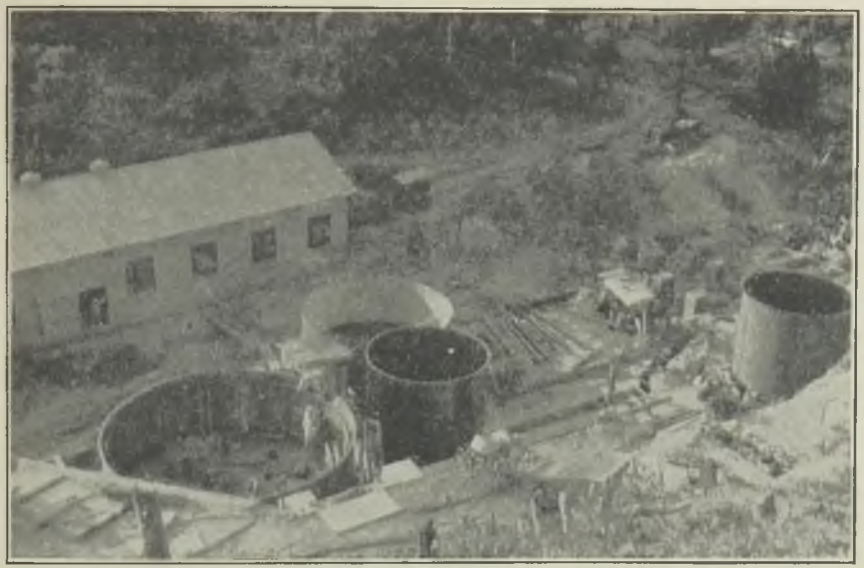
The Holy Ghost mine, which put out so much wealth, consisted of an almost vertical pipe of ore and it is not unreasonable to expect that such another pipe may be discovered in this district. The hills are thickly timbered and therefore difficult to prospect, but when time permits it is the intention to make a close geological survey and, within the limits thereby set out, to prospect intensively for a similar occurrence to that which in the old Spanish days produced so much gold.

Prior to our examination of the Cana plateau and the Balso and Sabalo Rivers our work had mostly been confined to the region surrounding the Tuquesa River and its confluent streams. The Tuquesa is a tributary of the Chucunaque River. There Gibb had his men out following up the alluvial gold prospects in an endeavour to

THE AUTHOR'S CAMP IN DARIEN.

locate the source of the gold. Boring with a form of churn-drill, not suitable for the kind of ground being tested, was also in progress, but operations with this drill were suspended pending the despatch of more suitable appliances from England. A large alluvial flat in the lower Tuquesa had been partly tested and was beginning to show promising returns when it became necessary to move men and drills to test the more easily accessible alluvial areas on the Balsa and Sabalo Rivers.

I recently revisited the Chucunaque River, on the banks of which alluvial gold containing an appreciable amount of platinum had been found. I also went 25 miles up the Tupesa River, one of its tributaries, to examine a gold-with-platinum prospect.



Part of Remance Cyanide Mill and Machine Shops.

At the time of arrival of General Rice and H. H. Watson, about April, 1928, a good deal of pitting had been done on the bank of the Balsa River at El Palo, but, although some of the values were good, the ground, taken as a whole, did not give promise of profitable exploitation. Attention was then given to the Balsa River, which has a gravel bed about 250 ft. wide and of an eminently suitable character for dredging.

Numerous scout holes were put down in the bed of this river over a length of 17 miles and some excellent results were obtained. The values, for instance, shown in a 10 ft. hole at Tucuti were as high as 119·7 cents per cu. yd. Another hole in the river bed near Tucuti gave 28·6 cents per cu. yd. over a depth of 37 ft., whilst 200 yd. above Tucuti the values mounted to 33·8 cents per cu. yd. for a depth of 39 ft. Opposite the El Palo camp, some five miles below Tucuti, the first hole put down gave a return of 51·2 cents per cu. yd. over a depth of 11 ft. 8 in., but in spite of these and other high values obtained the continuity of payable gravels was not such as to warrant the installation of a dredge. An interesting find during scout-holing was the piercing of what appears to be an old cross-river containing highly payable gravel under a covering of mud at least 60 ft. deep. Taken together, the depth and nature of the mud render the exploitation of the deposit unpayable, but as, either up stream or down stream of this ancient river, the overlying mud should become shallower or perhaps disappear altogether and the gravel thereby become payable further attention will be directed here when opportunity permits.

I am afraid Gibson had rather a rough time drilling from pontoons the bed of such a river as the Balsa, which is subject to rapid rises and floods, and it must have been with much relief that, under instructions from H. H. Watson, he transferred himself and his outfit to the comparatively quiet jungle on the banks of the Sabalo, a tributary of the Balsa. Here payable primary gravel beds were discovered and intensive boring was instituted to such good effect that hydraulicking operations should now be in full swing.

The gravels which are to be washed consist of rounded particles of all sizes from fairly

big boulders in the upper portion of the flats down to fine sands in the lower portion. There is very little quartz to be seen, most of the material being andesite and granite. The bed-rock is generally soft and decomposed at its junction with the gravel and is easily workable. Over a great part of the area the bed-rock is below the existing river level and this has necessitated the installation of elevators to deal with the material to be removed when hydraulic sluicing is in operation. The drilling has shown the depth of gravel to vary from 5 to 24 ft., with an average of nearly 13 ft.

The Manuel Flat part of the area was proved by nineteen lines of drill holes, some lines being 660 and other lines 330 ft. apart. The distance between the holes in each line was 66 ft., giving in the one case one hole per acre and in the other case two. The Chati-Chanati block has been proved by another series of holes to have an average depth of 14·3 ft. The recoverable value of the gravel in the Manuel Flat area is calculated from the bores to average 18·29 cents per cu. yd. and that from the Chati-Chanati area 18·62 cents per cu. yd. The working costs are estimated at 10 cents per cu. yd.

Preliminary surveys showed that a ditch line, some 8½ miles long, would bring water into the paddock at an elevation above it of 120 ft. Later surveys showed that this head could be increased by 60 ft. without materially lengthening the ditch. It was therefore decided to instal three monitors and three elevators, having two of each in constant use and keeping the remaining monitor and elevator for spares when shifting. The ditch is 6 ft. 6 in. wide at the top, 5 ft. wide at the bottom, and 3 ft. deep, and a depth of 2 ft. of water is allowed for in the ditch, which has a fall of 8 ft. to the mile. The ditch runs to within about 700 ft. of the working paddock and from it a 22 in. pipe line of 14 gauge leads down to the flat, where branch lines 8 in. in diameter lead to the monitors and others 11 in. in diameter lead to the elevators, which will raise the gravel through a vertical height of 28 ft. The throat pieces of the elevators are 8 in. in diameter. The monitors are fitted to take the 2 in., 2½ in., and 3 in. nozzles which are provided. A branch line from the 22 in. pipe runs to the electric light station, to which it conveys the necessary water for generating the current. The cost of benching by mechanical shovel—half-yard, full-swing, internal combustion, caterpillar—ran out at 25 cents per cu. yd., as compared with 35 cents per cu. yd. by manual labour. The high cost of mechanical work was due to the roots and stumps encountered and to the fact that the sticky nature of the ground made it difficult to clear the shovel dipper when emptying. From these figures it would appear that the mechanical digging would be the cheaper, but, on account of the extra excavation which was necessary for the accommodation of the shovel beyond that required for the actual formation of bench and leat, the cost per lineal foot run was considerably higher for mechanical work than for manual labour.

In the earlier days, when the men were unaccustomed to the work and were suspicious of piece work, the costs per yard for hand labour were approximately twice as much as those quoted, but when the men became more used to the work and found that at the very fair figure set by the corporation they could make so much more money on contract than on daily wage they eagerly entered into piece work contracts, with benefit to themselves and to the advantage of the corporation. The whole of the work in the Darien concession has been under the direction of H. H. Watson since his first arrival in the field in 1928.

The Spaniards were great old prospectors and paid much attention to this particular part of the country. They were able to wash the elevated gravel banks and the shallower deposits at the heads of the creeks and rivers, but were unable to cope with alluvial deposits of any depth below existing water level. Close to the lower end of the ditch line some of the paved streets of the old town of Santo Domingo can still be seen, and also the pit to which tradition has given the name of "The Treasure Hole." Whether treasure was secreted here or looted from here or whether it was a hole in which specially rich alluvial gold was found history does not relate.

There is a good deal of folk lore attached to the Marea River, which flows closely parallel to the Balsa. One does not believe much of the ancient tales one hears, but it is unwise totally to disregard them. As far as the Marea River is concerned, rumour states that in the time of the Spaniards the gold was so rich in the El Pablo reef that it was cut out with chisels. No work has since been done and the mine is now filled with water. Then there is the story of the two Englishmen who worked the gravels of Timbeyo Creek and were murdered for the large amount of gold they had won. Further, at El Salto—the junction of the Nupe and Marea Rivers—there is a big pool in which

two cases of gold are said to have been dropped by the Spaniards whilst pursued by enemies. There have been many attempts to salve this gold, but the pool is too deep for successful bare-skin diving and the Americans who about 30 years ago tried to obtain the gold by diverting the river were unsuccessful.

One of our prospectors, Donald Foster, with the guidance of the two "oldest inhabitants," visited the old French workings of 50 years ago where much gold is said to have been won and it has been arranged that the whole of this promising area will receive close examination. It is interesting to note the equivalent of 43½ oz. to the yard, "if it had continued."

The difficulties which had militated against working in this district in the past—those of approach from sea and land—have now disappeared, but even in spite of those difficulties the ore from Magaja lode was successfully treated by means of wooden-stemmed stamps and amalgamation. The old batteries stand to-day and, no doubt, would have been worked for a much longer period than was the case had not the owner of the mine been murdered on the overland track for the gold bars which he carried.

I have had samples taken from the

A Clearing through the Jungle for a Pipe-Line.

that hot springs are found on the banks of this river.

Leaving Darien, the next most interesting alluvial proposition in the concessions is that at El Mineral, on the Atlantic coast of the Veraguas concession, where production will have begun before the end of March. This part of the concessions was practically uninhabited, save for a few fishermen and turtle hunters who lived at the mouth of the Rio Concepcion, but it has always been famous for the wealth which has been won from the alluvial gravels and from the Magaja reef. It was my good fortune within two days of my first arrival in Panama City to meet an energetic and adventurous American who had spent quite a considerable time in washing gold from the rich gravels of Eagle Creek. Not many months afterwards one of our prospectors took 14½ oz. of gold, in heavy nuggets, from a small hole at Cucullo, 3 ft. long, 3 ft. deep, and 1 ft. wide—Magaja lode which had assayed 4 oz. 3 dwt. and 4 oz. 18 dwt. of gold per ton over widths of 36 and 32 in.

During my first visit to the Atlantic coast of the Veraguas concession I was shown an expansive flow of lava under which many old inclined tunnels had been driven. At the time of my visit all these tunnels were filled with water, but the reputation of the country was such and the tales of nuggetty gold so insistent that I thought the project to be one worthy of further investigation. It seemed to me that the mining operations of the past had been hampered by excess of water and lack of machinery to cope with it. I therefore advised my directors that there was a good chance of profitably working if the water could be drained off. They quickly fell in with the suggestion to test this ground and the work was eventually taken in hand, but it was not until Leighton took charge of the work that real progress

was made. Leighton brought into the work both hard work and intelligence. He surveyed the various blocks of lava, took the necessary levels, and what had appeared to me to be absolutely flat surface of columnar basalt traversed by the track from Cucullo to the sea proved to have the fall necessary for such a lava flow. This lava has been proved to have a thickness varying from 1 ft. to 65 ft. and covers an ancient river bottom, in which the gravels contain very nuggetty gold. So far as our work has been carried all the gravels in this river-bed carry gold, the nuggetty gold occurring in sporadic patches. This lava-capped old river channel lies between the Barrera and Santiago Rivers. Leighton and his staff have followed both the source of the gold and the point of origin of the lava flow, the former having been traced

Camp Pool on a Darien River.

to Magaja Hills and the latter to the Barrera Ranges.

This lava flow has been cut in several places into blocks by natural denudation and these have been numbered from 0 to 4. There is also what is known as the South-West Lava Block. The largest of these blocks is block No. 1, which has an area of approximately 59 acres. In addition to these blocks, which cover the old river bed, there are the blocks of auriferous caliche, which will also be washed for their contents.

For the year to the end of November last Leighton's log was 4,851 ft. of Banka drilling, 942 ft. of shafts sunk in the alluvial flats, and 1,850 ft. tunnelled under the lava—not a bad record. He has also surveyed, cleared, and formed 7,700 ft. for the pipe-line and has constructed his penstock dam, which on the night immediately after its construction had been completed was flooded to a depth of 3 ft. by a sudden rise in the river. It withheld the strain splendidly and I hear that even greater floods have been experienced with no damage done.

It is, of course, difficult to estimate the value of nuggetty gravel such as that which underlies the basalt, but we have sufficient evidence to prove that the exploitation of these gravels will be highly remunerative. In order to work these "deep-lead" gravels a pipe-line 7,700 ft. long has been constructed. The water will be carried underneath the lava for the purpose of washing the gravels somewhat on the pillar-and-stall system. I must confess that when this system of working was first mentioned I had some doubts as to its safety, because my previous examinations of the old tunnels had been limited on account of the water which filled them, but during my recent visit I was fully satisfied, after examination of the tunnels driven and observation of the coarse boulders with which the gravel is in most places strewn, that the system of work to be adopted will be perfectly safe if due care is exercised not to open spaces of too great an area at any one time.

In addition to these lava-covered gravels the Barrera River also has been proved to contain payable quantities of caliche and gravel. The caliche runs from 13·5 to 26·3 cents per cu. yd., as far as has been proved, for a depth of about 4½ ft., and the alluvial gravels run from 25 cents to 55 cents per cu. yd. over a depth of 9 ft., but what appeal to me even more than what has been here described are the gold-dredging possibilities of the lower Concepcion River, into which the gold washed from the breaks in the lava-covered gravels and from other sources has been deposited. A few bore-holes which have been put down show a great depth of gravel. One of these bore-holes failed to touch bottom at 102 ft. The outlet for the gravel after it leaves the lava-covered area has been traced right down to and beneath the sea. It would seem from the work done that we may expect a gravel bed at least 90 ft. in depth. The advantages of such a dredging proposition, supposing that it contains even a moderate amount of gold, are obvious. With such a wide area and such good depth the value per cubic yard need not be nearly so high to become profitable as would be necessary in more confined, shallower, and less accessible ground, where the moving of the dredges would be frequent and where fuel and other supplies would be expensive.

The area under review is so easily accessible from the sea that oil fuel, either for steam-raising purposes or for internal combustion engines, could be landed on the dredges at a minimum of cost.

So far I have dealt with only the area

immediately surrounding the El Mineral proposition, but there are many other places—lode and alluvial—which remain to be explored. The progress made since my previous visit has been remarkable and I look for much in the future when the present system of hydraulicking has got into swing and will allow expert attention to be diverted to other portions of the property.

This ends a brief survey of the alluvial position at Panama as it is to-day. I have run but lightly over the proposition because space does not allow of a more detailed description. So far, even after four years of energetic work, we have actually tested only a small portion of the many square miles of the concessions. We have had our men wide flung through the jungle and open country, making preliminary examinations and breaking the way for subsequent closer investigation, and, having done so much of this preliminary work, we are now in an assured position for carrying on the necessary detailed examinations in those districts which promise to give the most speedy returns. The prospecting of the alluvials is slow work, because gold pannings from the surface do not indicate the valuable contents of the underlying gravels, and, metaphorically speaking, the prospector in this part of the world must carry a Banka drill in his pocket.

Penstock Dam for the El Mineral Pipe-line.

Before concluding this part of my narrative I should like to add an appreciation of the work done by four of the earliest pioneers of this undertaking. I refer to J. J. Calderwood, whose deep insight into and sympathy with the characteristics of the Latin-American people have so strongly cemented the good feeling which exists between the Panamanian nation and the Panama Corporation to-day; to J. M. Henderson, whose wide knowledge of the country and whose infinite capacity for accurate detail have been of so much value; to Alan Gibb, although not now with us, whose pioneering work will long stand—an excellent geologist, a keen observer, a man of frail body but indomitable will, beloved by the natives; and to A. Keiller, with his wide knowledge of the Western Concessions. I have spent many days and travelled many miles, amule and afoot, with Keiller, a tall man of wiry frame, and of dour persistence. Following him on foot, over mountain ranges and sea beaches, with his steady plod, plod, plod, I should never have been surprised if, on looking up, I had seen in front of me a figure clothed in white, carrying a scythe over his shoulder. Keiller always seemed to me to be the inexorable embodiment of Father Time. In spite of my age and weight I believe that he and I put up more than one speed record for the country over which we travelled on foot.

From each of these men I have for all time received the plain, unvarnished truth of the situation and outlook, free from all exaggeration, as these have appeared to them and it eased my way on my first examination of the property, whilst acting in the capacity of an independent inspecting engineer, to find all of them so transparently honest in intent and of such obvious integrity.

NOTES ON THE PROVISIONAL CORRELATION OF THE ROCKS OF SOUTH AND CENTRAL AFRICA.

By G. C. BARNARD, A.I.M.M.

In the tables accompanying this article the author places side-by-side with current views of South African stratigraphy the results of his own recent observations in the Belgian Congo and Northern Rhodesia.

In Central Africa the lowest fossiliferous beds are those of the Karroo, thus, in order to correlate the underlying beds with those of South Africa, it is necessary to rely mainly on the lithological characters of the various formations, taking into account the conditions under which they were laid down, that is, the land surface and climatic conditions, any widespread fracturing or folding movements and, also, any periods of igneous activity.

The correlation tables which accompany these notes are more or less self-explanatory, but certain features are worthy of more detailed explanation.

(*a*) The *Archaean Basal Complex* outcrops sporadically as inliers throughout the African continent. It consists mainly of very old rocks, in the greater part schists and gneisses of both igneous and sedimentary origin. These were intruded by the Old Granites, which in many instances are now gneissoid in structure. The schistose *Muva System* unconformably overlies the above basement series. The disputed age of the Old Granites is definitely shown to be post-Archaean and pre-Muva by the occurrence of pebbles of the Old Granite in a conglomerate at the base of the Muva beds which was shown to the writer by Dr. D. Davidson between Chambishi and Mufulira in N. Rhodesia.

(*b*) There are no counterparts of the *Witwatersrand and Ventersdorp Series* yet identified in Central Africa. If these formations ever existed in this area they were probably eroded before deposition of the succeeding System.

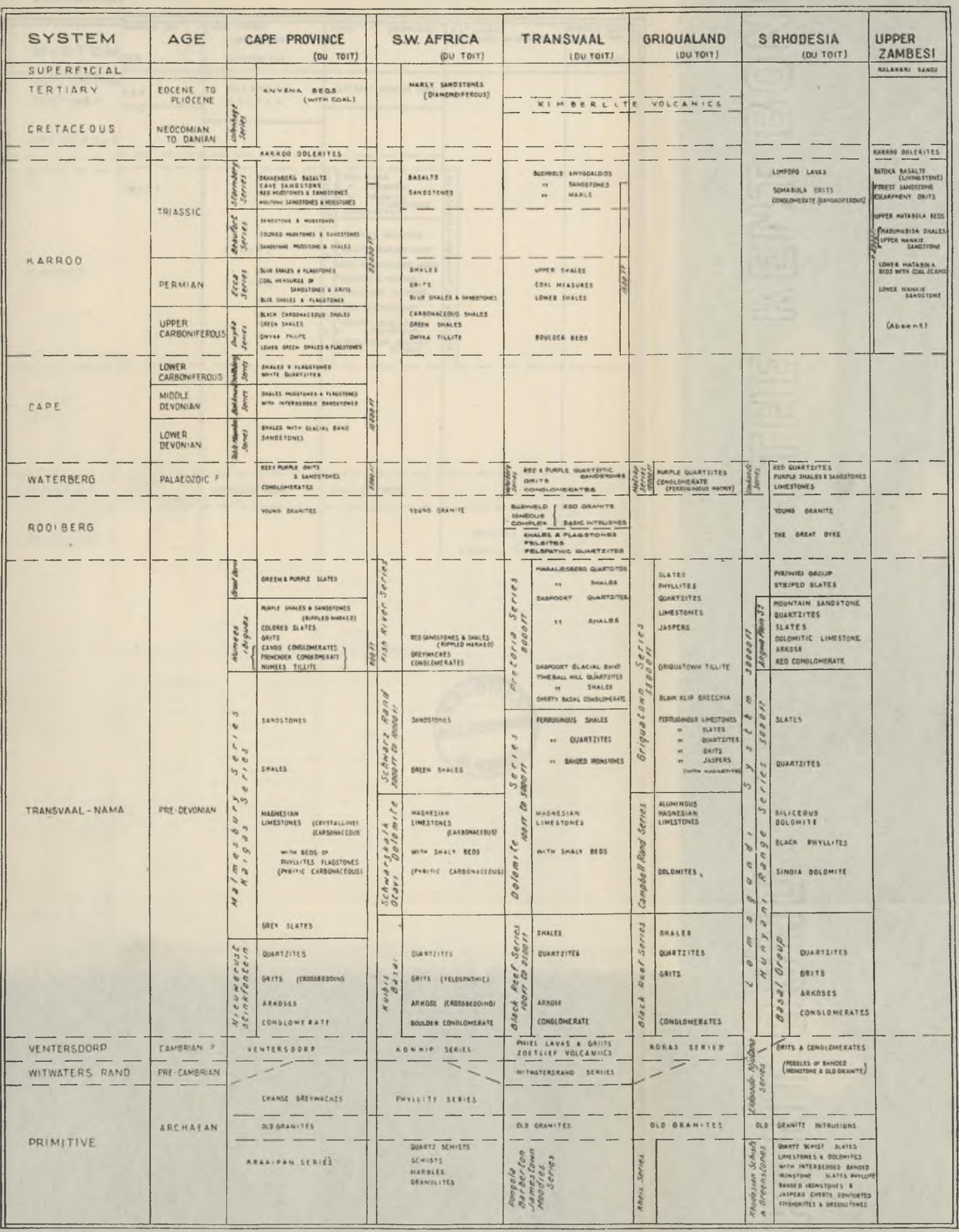
(*c*) On the other hand the *Katanga System* is characteristic, not only generally, but also in detail, of the *Transvaal-Nama System* of South Africa. The main feature, among many striking similarities, is the huge thickness of the magnesian-limestone series, which represents by far the most prolonged deep water phase in the life of the African Continent: such a highly developed carbonate zone is found in no other system. A subsequent glacial period supervened which extended from the south as far north, at least, as the Katanga, the Numees, and Griquatown tillites undoubtedly being one with the Katanga tillite.

From the bottom of the systems to the top the similarity between the Katanga and the Nama-Transvaal Systems is striking. The base is constituted by boulder conglomerate succeeded by arkoses, felspathic grits, sandstones and quartzites, which are in turn overlain by the magnesian limestone zone, partly graphitic. Superimposed on these are calcareous and graphitic shales and sandstones, jasperoid beds, magnetite-sandstones and the tillite, followed by calcareous shales and sandstones, often ripple-marked. These upper beds are not so true to type throughout as are the Middle and Lower Series.

(*d*) Subsequent to the deposition of the Katanga and Nama-Transvaal Systems came a series of mountain-building movements accompanied by intense igneous activity. These movements caused the overthrusting and dragfolding so highly developed in the Mine Series of Central Africa, at the same time producing the steep folding of the overlying Lufira Series.

The basic differentiation product of the Bushveld igneous magma was first injected at the contact between the Pretoria and the Rooiberg Series of the Transvaal System. It is significant that the highest horizon in which these diorite-gabbro sills of Central Africa are found lies, more or less, between the Upper and the Middle Mines Series, which correspond to the Pretoria and the Rooiberg Series of the South. In the later acid phase of differentiation the Young Granites were injected into these beds, but were unable to penetrate to such a high horizon as the more fluid basic magma, for, as a rule, this granite does not transgress any beds higher than the Lower Mine Series. Both this granite and the diorite-gabbro carry small quantities of iron sulphides, which are in some cases cupriferous, but there is little doubt that the granite magma played the greater role as a cupreous mineralizer.

(*e*) After the mountain building movements and uplift previously referred to, a period of peneplanation took place. This was followed by submergence, with the erosion of the unsubmerged folded Mine (Transvaal) Series, the granite, etc., the sediments forming the flat Kundelungu (Waterberg) Series consisting mainly of



Broken lines indicate unconformities.

[*To face p.* 210

felspathic quartzites, generally purple in colour, shallow water conditions being indicated by frequent ripple-marking.

(*f*) Above the flat Kundelungu System the next formations met with in Central Africa are those of the Karroo System, there being abundant evidence that they belong to this system. Drilling by the Rhodesia-Katanga Co. on the Kafue Flats has shown a tillite at the base of the Karroo beds, above the Archaean basement schists, at a depth of about 150 ft. below the Ecca Coal Measures. This tillite contains striated pebbles which appear to be typical fragments of the Kundelungu and Lufira beds. P. Fourmarier also mentions a " basal glacial conglomerate " in the Karroo formations (Lukuga) in the Eastern Congo. There is little doubt that this bed is equivalent to the Dwyka tillite of South Africa, although it has a much smaller thickness and is altogether absent in Southern Rhodesia and in the Karroo deposits of the East African belt.

The Lubilache beds, above the Lualaba beds, belong, it is practically certain, to the Stormberg Series, thus the Cave Sandstones of the Cape are repeated in the Bushveld Sandstones, in the Kalahari Sandstones, in the Forest Sandstones of the Zambezi, in the extensive Lubilache Sandstones of the Congo, Angola and N. Rhodesia, in the Red Sandstones of Nyasaland and Tanganyika, and in the Duruma, Lugh, and Adigrat Sandstones of the Eastern Belt.

There is no reliable evidence that there has been any period of submergence of the Central African Plateau since the uplift of these Lubilache beds, whilst their age has been determined as Rhaetic up to Bathonian by the flora and fauna they contain. During all subsequent periods these beds have undergone dessication and peneplanation resulting in the formation of the great thicknesses of the detrital Kalahari Sands and the Lubilache Sands, which have frequently been cemented by silicification. These sands were easily confused with the parent Kalahari and Lubilache Beds *in situ*, and the fauna they contain has been falsely applied to give an Eocene or Pliocene age to the parent formations.

(*g*) It is to be hoped that a definite succession and correlation of beds may be followed up through the Congo to connect more positively with the work of the geological surveys in Angola, Tanganyika, Uganda and the Sudan. The widespread occurrence of Karroo formations, over vast and also small areas in Central and Southern Africa, with their typical flora and fauna, the frequent exposures of the Primitive Basement Complex, the careful search for glacial formations, the occurrence of the deep dolomite series, and numerous other points, should all assist in establishing a definite correlation with a general nomenclature of the systems common to all countries of the African continent.

Detailed Correlation of the Katanga and Kundelungu Systems of the Katanga and of N. Rhodesia.—(1) The basal boulder conglomerate of the Mine Series, unconformably overlying the Muva Schists, which outcrops in the Kafue River to the East of N'changa, N. Rhodesia, and which is also found underground in the Roan Antelope Mine, for example, exactly resembles the N'zilo conglomerate, which also lies on the Muva Schists. The N'zilo Conglomerate is exposed in the N'zilo Gorge, Katanga, and there can be little doubt that it is the same bed as that which occurs at the base of the Mine Series.

(2) The basal tillite of the Lufira (Mutondo) Series, outcropping in the Mutondo River to the north of Mufulira, is typical of the tillite (" Grand Conglomerat du Katanga "), at the base of the Lufira Series in the Katanga. At the Mutondo the tillite is overlain by weathered rose-coloured calc-shales, typical of the Lufira Series, and carries a limestone bed at the horizon of the Kakontwe Limestone of the Katanga. The tillite of the Mutondo is underlain by the oolitic quartzites, graphitic shales, and sandstones with dolomite bands, of the Upper Mine Series (Christmas), which are true to the type of the Mwashia (Nguya) Series of the Katanga. These Upper Mine beds at Mufulira have a thickness of about 2,000 ft., whilst below them is the dolomitic zone of the Middle Mine Series (" Upper Roan," " Serie des Mines "), followed by the more argillaceous and finally felspathic members of the Lower Mine Series (" Lower Roan," " Serie de Base ").

(3) These two key beds, the Katanga Tillite and the N'zilo Conglomerate, define the top and bottom respectively of the Mine Series in an unmistakeable fashion, whilst there is no doubt that the intermediate dolomitic beds (Middle Mine Series), in which the ore deposits of the Katanga occur, (" Serie des Mines "), are equivalent to the dolomitic series (" Upper Roan Series "), of N. Rhodesia. Naturally over such a

distance there are differences in detail in the component members of a series; also in the Katanga the dolomitic beds have been more highly altered near the surface by the effects of weathering, mineralization, oxidation, and silicification. In depth, however, although at the surface the individual members are completely different in character, they are all crystalline siliceous dolomites.

At Chambishi in the Middle Mine beds, examination of the drill-cores showed a bluish-grey dolomite (about 600 ft. thick), underlain by 200 ft. of quartz-talc shales, followed by about 90 ft. of a white saccharoidal, talcose, magnesian limestone. The dolomite and the limestone very closely resembled the "Dolomie Superieure" and the "Dolomie Inferieure" of the "Serie des Mines" of the Katanga, and there is little doubt that they are of the same horizon.

Again, the felspathic beds of the Lower Mine Series have now been definitely established at Chituru and Kambove in the Katanga underlying the Serie des Mines; this Lower Mine Series had not definitely been previously identified in the Katanga.

(4) The conformity of the three divisions of the Mine Series to each other may be seen at many localities, whilst the overlying Lufira Series is conformable with the Mine Series, and not unconformable as stated by Kovaloff, a gradual transition from the Upper Mine beds to the Katanga tillite being normal. In addition, the tillite is followed in gradual transition by the calc-shales of the Lufira System.

(5) It has been found necessary to divide the previously named Kundelungu Beds into two series; the lower highly folded calcareous portion has been separated as the Lufira Series and included in the Katanga System (following F. E. Studt's original nomenclature); this series has been subjected to the mountain building movements of the period of the Young Granite intrusion, whilst the upper, flat, felspathic, arenaceous beds (Plateau Arkoses), form another series, post-mountain building period, for which the name Kundelungu has been retained, as it is chiefly on the plateau of this name that these beds are found.

Some years ago the writer observed strong evidence of the unconformity between these two series along the Ninga Gorge on the southern edge of the Biano Plateau, Katanga. In addition, the lithological characters of these beds place them as being the most likely equivalent to the Purple Quartzites of N. Rhodesia, the Umkondo Series of S. Rhodesia, and the Matsap and Waterberg Series of S. Africa. Although the Congo geologists have for the time being included the Plateau Beds in the Katanga System, they are not fully convinced on this point and are not unanimous, although some claim to have established the fact that there is no unconformity between the Plateau Beds and the Lufira Beds. Again a geological map of the Katanga indicates an overlapping of the Plateau Beds over the underlying Lufira Series, whilst, as previously stated, their lithological character, and the fact that they are post-mountain building movement, and hence post-intrusion period, fully justifies classing them as a separate system until positive proof is forthcoming that they are conformable with and part of the Katanga System.

(6) Speaking generally, one or more of the ore-bearing beds of the two countries, whether in the Middle or the Lower Mine Series, are graphitic: near the surface the graphite is oxidized, as may be well seen at the Kansanshi mine (whilst occasionally in the Union Miniere's mines an unbleached graphitic "kernel" is seen in the "Schistes Dolomitiques" (these beds being highly graphitic in depth). The role played by the original carbon content of the ore-bearing beds in Central Africa in the selective mineralization of those particular beds has not yet been sufficiently stressed or studied to the extent that it merits. The action of carbon as a precipitant and "fixer" in cases of the hydrothermal type of mineralization has been exhaustively studied with reference to the Kupferschiefer of Mansfeld and the Banket of the Witwatersrand and the results of these researches could be applied with advantage to the solution of this phenomenon of selective mineralization in these Central African bedded deposits.

(7) Further geological survey work, mining, and deep drilling work should shortly make the correct correlation of the beds of the Katanga and N. Rhodesia a *fait accompli*; however, on present knowledge the above represents the facts as fairly as possible.

The writer does not claim as original work the correlation which has been outlined in this article, as it has been mainly a matter of arranging and tabulating work done by others, guided however by the experience of nine years' geological study, mainly in the Belgian Congo, N. Rhodesia, S. Sudan, Uganda and Tanganyika, with visits to Angola, Kenya, Mozambique, S. Rhodesia and the Union of S. Africa.

THE SELECTION OF A MINE FAN

By H. G. SMITH, B.Sc.

In this article the author examines the factors governing the selection of a mine ventilator which will operate with satisfactory efficiency during the life of the mine.

In the past the ventilation of many metal mines has been notoriously bad, many of them relying solely on natural agencies for their ventilation. With the exhaustion of minerals at shallow depths, and the consequent necessity of deeper mining, temperature began to play an important part, tending seriously to limit human effort. The ill effects of temperature can only be alleviated by adequate ventilation and the menace of silicosis can also, to a great extent, be allayed by the passing of copious volumes of air through the mine workings.

The occurrence of dangerous gases is more prevalent in coal mines than in metal mines and the presence of this potential source of danger has had the effect of enforcing the maintenance of a good standard of underground atmospheric conditions in coal mines —the centrifugal type of ventilator having for many years been a means of ensuring that standard. In the following article the writer attempts to provide a solution to a difficult problem—namely, the selection of a mechanical ventilator for a mine which will operate with satisfactory efficiency throughout its life.

If it is decided to install a mechanical ventilator in a mine it is essential that the type of ventilator chosen should perform its duties as efficiently and as effectively as possible. The costs of ventilation are usually high, the annual cost of ventilating many collieries being often over £10,000 per annum and a decrease of 5% in efficiency means a loss of several hundred pounds per annum. When referring to the power consumed in the maintenance of ventilation in coal mines Sinclair and Statham state, "the energy consumed varies with the conditions . . . and may represent from 7% to 40% of the total energy consumed at a mine." [1] In the metalliferous mining industry this figure may be too high as the upper limit. Nevertheless, when a fan is installed it cannot fail to be other than one of the chief consumers of power.

The selection of a mine fan is at its best a hazard. The orthodox centrifugal fan is designed to operate at maximum efficiency only under one particular set of conditions. When either the volume or pressure, or both, are but slightly changed from such conditions, the fan falls rapidly in efficiency unless its internal resistance is high, usually an undesirable feature. With this type of ventilator there is only one adjustment, namely, speed, and while under constant resistance conditions the efficiency of a fan is independent of speed changes such an adjustment is insufficient to cope with the varying conditions inseparable with the progress of mining development. Apart from questions of design, the two predominant factors which may cause a mine fan to operate inefficiently are :—

(1) The normal development of the mine, and
(2) Natural ventilation.

Development.—When the mine is in the early stages of development, the roadways and airways are not usually driven to their full height and width, and furthermore the air current is not split. Hence the resistance of the mine at this stage is relatively high. As the workings extend, the main airways are driven to their full cross-section and are perhaps well lined, and the air current is split. At this stage of development the resistance falls, only to rise again in the later days of the life of the mine when the workings become extensive and the airways very long. The resistances of the shaft and fan drift remain approximately constant throughout the life of the mine.

Natural Ventilation.—Natural ventilation is so termed because the agencies producing it are natural rather than artificial. It is largely due to seasonal changes in the atmosphere above ground. In winter the amount of air circulated through the mine by natural agencies may be copious and thereby the apparent resistance of the mine against the fan will be low. In summer the volume circulated by natural agencies will be small, and in some instances the air current is reversed, and thus the apparent resistance against the fan will be increased. Hence natural causes may, and often do, give rise to what is equivalent to large variations in resistance of the mine, and in some cases the extreme fluctuations arising from these natural causes are far greater than those due to development.

[1] "Britain's Fuel Problems," 1927.

Measurements made by R. Clive[1] at Bentley Colliery, Yorkshire, showed that in winter, when the average difference in temperature of the upcast and downcast air was 27° F., the total amount of air circulated through the mine by the combined efforts of the fan and natural agencies was 309,530 cu. ft. per minute, and of this volume 200,000 cu. ft. per minute was due to natural ventilation alone. Clive also found that the apparent resistance of the mine against the fan varied from 0·89 atkinson[2] in summer to 0·39 atkinson in winter, and the power in the air supplied by the fan varied from 182 to 80 h.p.

In the face of this wide variance in the conditions under which the fan operates due to both development and natural ventilation it seems almost impossible to design a fan to meet these fluctuating conditions in an efficient manner. One point may be noted, however, it is better to ensure that the fan will work at its maximum efficiency when the power consumed will be a maximum, i.e. in summer, when the saving in power will be greater than if the fan were designed to work at its maximum efficiency in winter when the power consumption is least.

Fan and Mine Characteristic Curves.—These curves were first suggested by Dr. J. Parker[3] and comprise :—

1. Pressure-Quantity characteristic for the mine.
2. Pressure-Quantity characteristic for the fan.
3. Efficiency-Quantity characteristic for the fan.

(1) *Mine Characteristic.*—This is determined as follows : The fan is run at different speeds, and for each speed the quantity (Q) in kilocusecs[4] and the fan drift pressure (P) in lb. per sq. foot is determined. A graph is plotted with the values of Q as abscissæ and the corresponding values of P as ordinates. If natural ventilation is absent the resultant curve is found to conform approximately with the law $P = RQ^2$ where R = resistance of mine in atkinsons.

A typical mine characteristic curve is shown in Fig. 1. If natural ventilation is present the curve will not pass through the origin, but will cut one of the axes depending upon whether the natural agencies assist or oppose the working of the fan. The curve BC (Fig. 1) shows natural ventilation assisting the fan. In practice, the value of R can be determined by experiment. In the case of an undeveloped mine where the workings are to follow a definite plan a rough estimate of the value of the resistance of the mine in its various stages of development can be formed. A value for the resistance of the roadways can be calculated from the proposed dimensions and the knowledge of the coefficient of friction of the intended lining.[1] Knowing the number of splits in the air current at various periods in the life of the mine, approximate values of the limits of resistance of the mine due to development can thus be determined.

(2) *Fan Characteristic.*—This curve is supplied by the fan maker and is obtained by running the fan at constant speed and varying the resistance from zero to infinity. For each value of resistance the corresponding values of P and Q are determined. When these values are plotted, again with Q as abscissæ and P as ordinates, a curve similar to AB (Fig. 2) is obtained. Similar curves can be determined for the fan at different speeds, but provided that one curve has been accurately determined a characteristic for any other velocity can be obtained by calculation without any further experiment.

If the characteristic for a velocity V_1 (curve AB, Fig. 2) has been determined, the characteristic for a velocity V_2 can be estimated as follows. It is known that the fan drift pressure is directly proportional to the square of the velocity of the fan, i.e. $P \propto V^2$, and that the quantity circulated by the fan is directly proportional to the velocity, i.e. $Q \propto V$, so that by selecting any point Y_1 on the characteristic AB then the corresponding point Y_2 for the new characteristic is obtained as follows. The distance of Y_2 from the pressure axis is

[1] "True Effect of Natural Ventilation in Deep Mines," by R. Cluve (2nd report, Ventilation Committee) *Trans.* Inst. Min. Eng., vol. 67, 1924, p. 273.

[2] An atkinson is the unit of resistance which has been tentatively fixed by the Ventilation Committee of the Institute of Mining Engineers. An atkinson is that resistance which absorbs 1 lb pressure per sq. ft. when a current of 1000 cu. ft. per second is passing.

[3] "The Characteristic Curves of Fans," by J. Parker, *Trans.* Inst. Min. Engs., Vol. 63, 1922, page 222.

[4] A kilocusec equals a flow of 1000 cu. ft. per second.

[1] A list of the coefficients of friction as determined by several research workers is given on pp. 8, 9, and 10 of "The Ventilation of Mines" by Prof. H. Briggs. (Methuen & Co., 1929.)

that of $Y_1 \times V_2/V_1$ and the distance of Y_2 from the quantity axis is that of $Y_1 \times \left(\frac{V_2}{V_1}\right)^2$. In this manner several points can be found and a characteristic CD thus constructed for a new fan speed.

(3) *Efficiency Characteristic.*—The efficiency of a fan is the ratio of the output of the fan, that is, the h.p. given to the air, to the input, that is, the h.p. applied to the fan shaft. In practice the latter value cannot be determined and in consequence it is customary to measure the full h.p. supplied to the fan installation. The h.p. given to the air is the product of the quantity of air circulated in cu. ft. per minute and the fan drift pressure in lb. per sq. ft., divided by 33,000. This efficiency can be determined along with the fan characteristic provided the input to the fan installation is also measured. The fan efficiency is plotted against quantity. With constant resistance the efficiency of the fan is practically independent of its speed. The curve is of the form OC as shown in Fig. 3. The fan maker may attempt to design the fan so that the efficiency characteristic is as flat-topped as possible and thereby making it fairly efficient over a considerable range of resistance. As already pointed out this implies a high internal resistance of the fan unit itself.

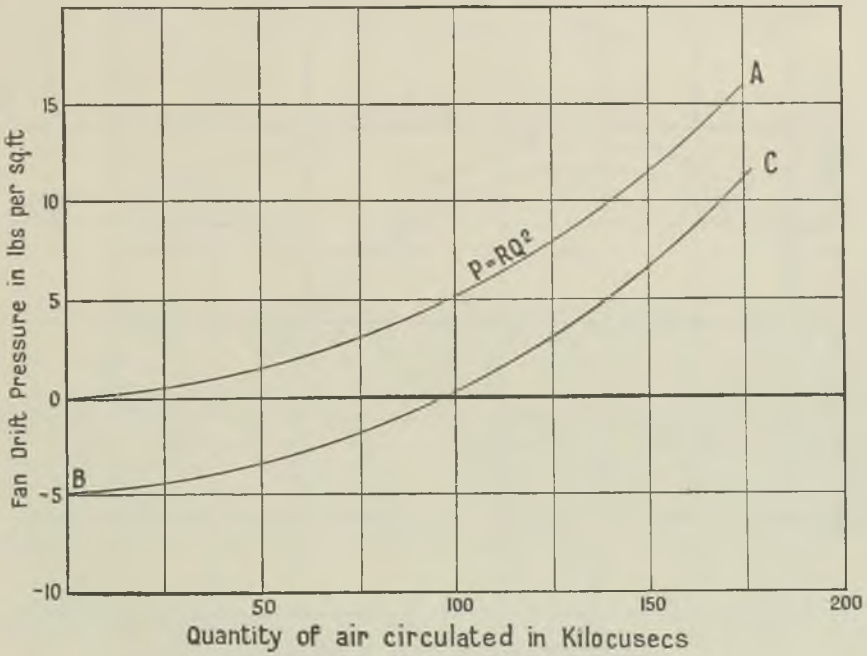


FIG. 1.

The graphs should now be superimposed as is shown in Fig. 4. The mine characteristic OA intersects that for the fan BC in the point E. A vertical line drawn through E cuts the efficiency characteristic at I and the quantity axis at F. This shows that if a fan with characteristic BC was ventilating a mine with characteristic OA the amount of air circulated throughout the mine would be the quantity represented by OF and the fan drift pressure would be that represented by EF. Under these conditions the fan would be working at an efficiency represented by IF. Now suppose that the speed of the fan is increased and a fan characteristic KL is obtained which intersects the mine characteristic at G. Under these conditions it will be seen that the fan will circulate a volume of air represented by OH through the mine when the fan drift pressure will be represented by GH. The efficiency of the fan is not, however, JH, but still IF, because, as already stated, the efficiency of the fan operating against a constant resistance is independent of the speed of the fan. The efficiency for points on the new fan characteristic curve can be determined by measuring the intercept cut off by the original efficiency characteristic from the perpendicular to the quantity axis drawn at the point of intersection of

the mine characteristic and the first fan characteristic.

THE USE OF CHARACTERISTICS IN THE SELECTION OF A FAN.—It is possible, by the use of these curves to determine the limits of resistance within which a fan can be operated without its efficiency falling below a desired minimum value, and furthermore to determine if the values of the mine resistance and the probable variations of the resistance fall between these limits.

Let BC (Fig. 3) be the fan characteristic and OC the efficiency characteristic which have been supplied by the fan maker. It is required that the fan shall operate with an efficiency of at least 50%.[1] A line DE is drawn, representing an efficiency of 50%, and is found to cut the efficiency characteristic at F and G. These two points mark the range of efficiency within which the fan must operate to maintain the desired conditions. Two lines are drawn through F and G at right angles to DE. These cut the fan characteristic at H and I. If the characteristic for the mine cuts the fan characteristic anywhere between the two points H and I it will mean that the fan will ventilate the mine with an efficiency greater than 50%. If the fan efficiency has not to fall below 50% the two limiting values of mine resistance permitted will be given by mine characteristics passing through H and I and their numerical values will be equal to—

$$\frac{JH}{OJ^2} \text{ and } \frac{KI}{OK^2}.$$

Should the estimated mine characteristic not fall within OH and OI then another effort will have to be made to find a fan to meet the estimated and desired conditions.

To overcome the difficulty of the change of resistance Parker [1] has suggested an ingenious method. It has been shown that natural ventilation when working in conjunction with a fan and in such a way that it assists ventilation decreases the apparent resistance of the mine. Such a case is similar to two mechanical ventilators working in series. Parker suggests that a small subsidiary centrifugal fan could be worked in combination with the main fan. When the resistance of the mine is high the two fans could be run in series, the small fan thus reducing the resistance of the mine against the large fan. When the resistance of the mine falls below that for which the main fan was designed, and consequently

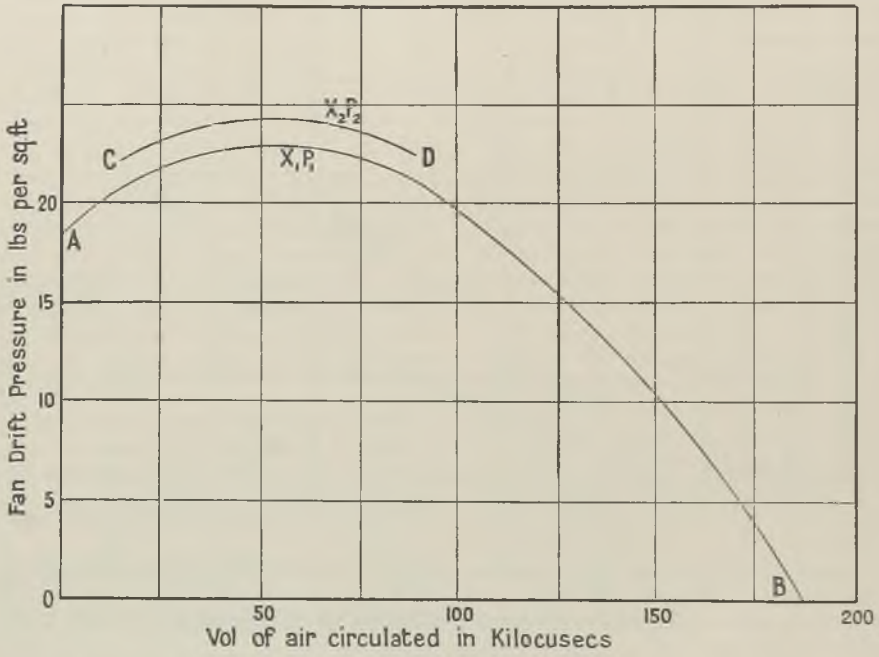


FIG. 2.

[1] Published records of fan efficiencies indicate that an overall efficiency below 50% is the rule rather than the exception.

[1] "The Choice of an Efficient Ventilator for a Mine" by J. Parker, *Trans.* Inst. Min. Eng., Vol. 68, 1924, p. 303.

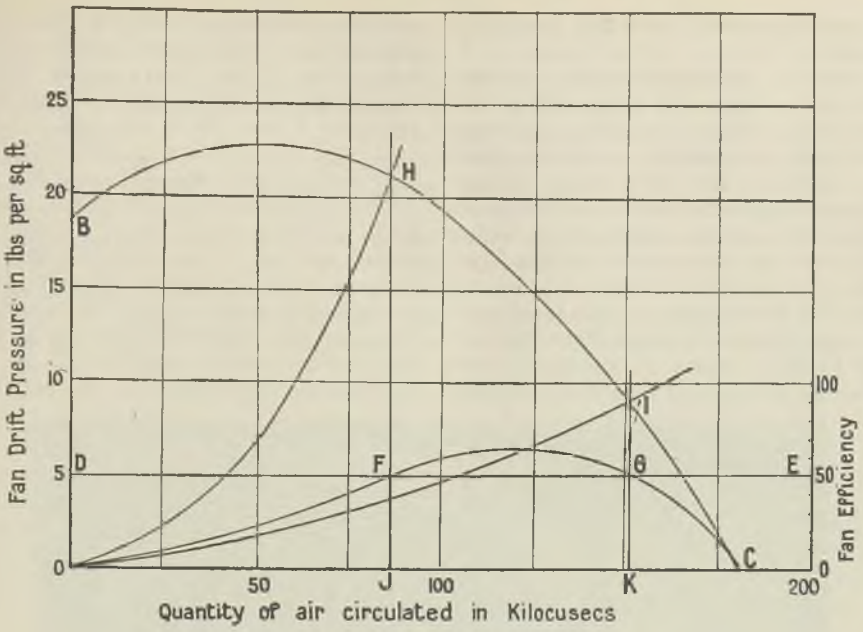


FIG. 3.

causes it to become inefficient, the small fan could be run in parallel. This would be equivalent to increasing the resistance of the mine. By thus manipulating the small fan the apparent resistance of the mine could be controlled between sufficient limits to ensure that the main fan worked against the resistance for which it was designed, and hence would be performing at, or near, its maximum efficiency. Such a method would perhaps be useful when it is found that an existing fan has become inefficient. This may be due to the fact that owing to the normal development of the mine the resistance has so changed that the fan is no longer operating against the range of resistance for which it was designed. Instead of scrapping the old fan and installing

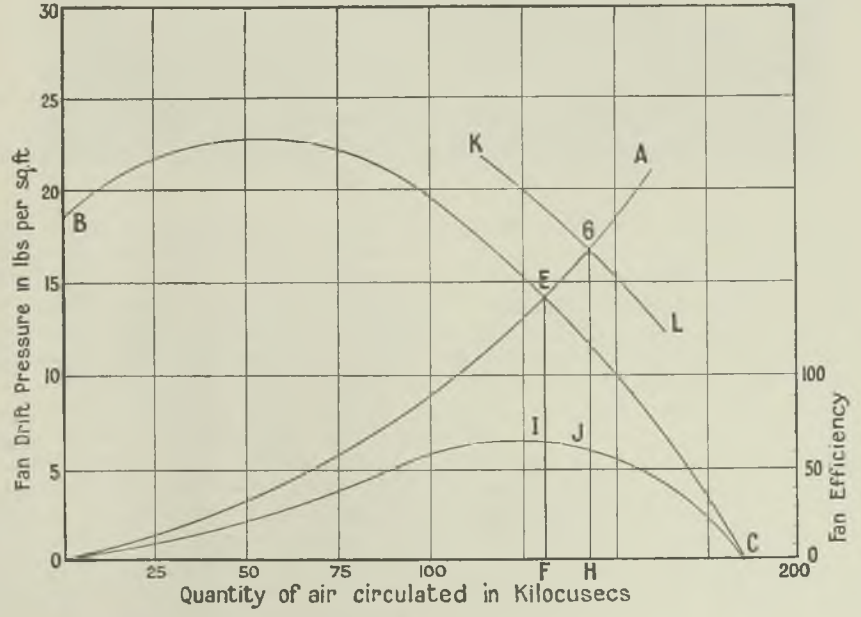


FIG. 4.

a new one it may be economy to erect a small unit to work either in series or in parallel with the main existing fan and thus diminish or increase the resistance of the mine by the desired amount. However, there are many objections to the adoption of such a scheme, the chief being the fact that mining engineers have, from practical experience, but little confidence in either the reliability or the economy of fan combinations. Especially is this so in the case of a parallel combination as it requires a careful adjustment of loads on the respective fans to prevent either of the fans from assuming the whole load and even drawing air from the outside atmosphere through the fan robbed of its load.

The most practical method of overcoming the problem of varying mine resistances is the employment of the Steart propeller fan. Early types of propeller fan were found to circulate large volumes of air, but only against very low resistances. However, according to the results of research work carried out by F. A. Steart [1,2] it seems as though this type of ventilator will become a serious rival to the centrifugal fan. The Steart fan consists essentially of modern aircraft propellers arranged in series on a steel shaft and caused to rotate at a high speed within a cylindrical casing. Fig. 5 shows the original Steart fan.

Steart conducted experiments at Northfield Colliery, Natal, with Curtis aircraft propellers 8 ft. 4 in. in diameter, and of varying pitch, mounted symmetrically on a steel shaft and spaced 9 in. apart. The pitch of the propellers was made variable by making the attachment of the blades to the boss adjustable. With 10 airscrews in series a pressure of 9 in. water gauge was recorded, thus destroying the old idea regarding the inability of a propeller type of fan to create a pressure. Moreover, when this fan was working against ordinary mine resistances large volumes of air could be circulated with a good efficiency.

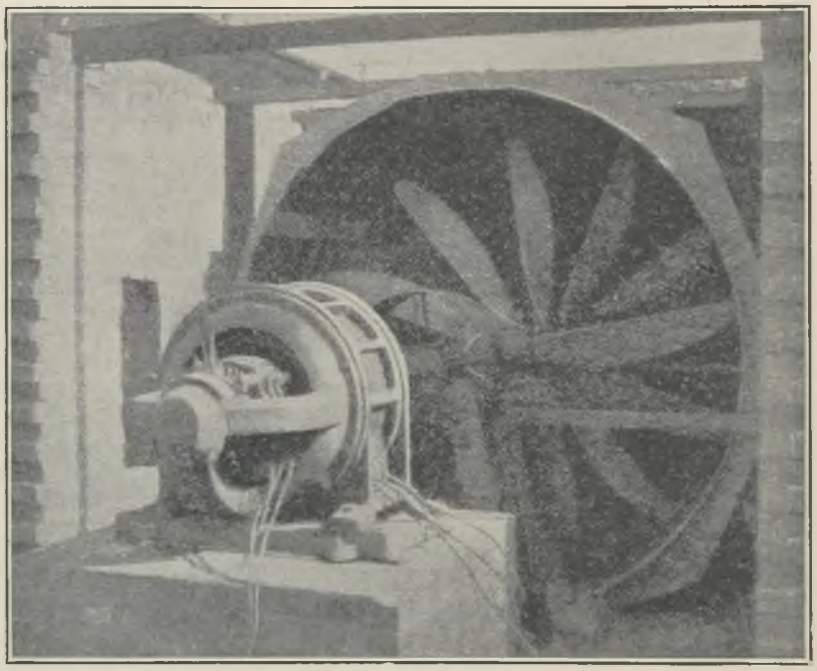


FIG. 5.—EARLY STEART FAN.

Recent tests have shown that there is a probable relationship between the pitch and the number of the propellers and the resistance of the mine. According to Steart the following relations hold: (1) The pitch is inversely proportional to the square root of the mine resistance in atkinson's, and (2) the resistance of the mine in atkinsons is directly proportional to the number of

[1] "Notes on Application of Air-Screws to Mine Ventilation" by F. A. Steart, *Journal* of Chem. Met. and Min. Soc. of South Africa, 1923, Vol. XXIV, p. 31.

[2] "The Application of Air-Screws to Mine Ventilation" by F. A. Steart, *Trans.* Inst. Min. Engs., Vol. LXVIII, 1924, p. 310.

air screws in series. Thus it will be quite a simple matter, once the mine resistance is known, to decide the number of propellers or the size of pitch most suitable for a definite resistance.

By boring holes in the fan casing and inserting water gauges, Steart showed that the pressure of the air in the fan is built up in stages by each stage of the air screws, and as each screw passed the same volume of air he says the mine resistance is therefore dealt with in stages. The propeller fan would thus seem to build up pressure in stages like a turbine.

The advantages of this type of ventilator over the centrifugal fan are as follows :—

(1) *Flexibility.*—The fan can be adjusted to cope efficiently with variations in resistance or volume by changing the speed, the number of blades on the shaft, or the pitch of the blades. With the centrifugal type, speed is the only adjustment. For a low mine resistance a few propellers would be sufficient. An increase in resistance demands a reduction in pitch and an increase in speed to maintain the volumetric discharge.

(2) *Reversal.*—The air current can be reversed merely by reversing the direction of rotation of the fan. Reversal doors are hence not required.

(3) *Drive.*—With the high rate of revolution required the fan lends itself to direct drive from an electric motor.

(4) *Cheapness.*—The housing is simple and the installation easy.

Two of these fans have been installed in this country recently, both in Yorkshire. One is at Grange Colliery of Messrs. Newton Chambers and Co. Ltd., Thorncliffe, and the other at the Prince of Wales Colliery, Pontefract. Tests of the former gave mechanical efficiencies of well over 60%, and it is behaving very satisfactorily. One of our foremost authorities on mine ventilation has acclaimed the Steart fan to be the mine ventilator of the future.

BOOK REVIEWS

The Chemical Analysis of Rocks. By Dr. H. S. Washington. Fourth edition, rewritten and enlarged. Cloth, octavo, 296 pages. Price 20s. London : Chapman and Hall.

The revised edition of this well-known work is particularly welcome since it appears at a time when the importance of rock analysis is becoming more greatly appreciated, not only by the petrologist, but also by the economic geologist.

While the general course of analysis and many of the well-established methods for the determination of individual constituents have been retained, the opportunity has been taken thoroughly to revise the text and to add many new references. Descriptions are also given of several new and useful methods which include the cupferron method for titanium and the 8-Hydroxyquinoline method for magnesium. Several paragraphs are devoted to a discussion of platinum utensils and to the behaviour of various substitutes for platinum. After considerable experience, Dr. Washington recommends the use of " palau " (an alloy of 80% gold and 20% palladium) crucibles for sodium carbonate fusion and considers them far superior to those made of pure platinum or iridium-platinum for this purpose.

The views, conventions, and demands of modern petrology with regard to rock analysis are clearly set forth in the introduction, which has been largely rewritten. Preliminary chapters on " apparatus and reagents," " preparation of the sample," etc., have been completely revised, and many of the methods are described in even greater detail than formerly, thus continuing to endow the book with a special appeal to geologists and others with only limited experience in chemical analysis. More experienced analysts may regard much of the detail as superfluous—nevertheless, they will find it distinctly advantageous to employ this book in conjunction with the more advanced " Analysis of Silicate and Carbonate Rocks " by W. F. Hillebrand (U.S. Geological Survey Bulletin 700)—a work which is frequently referred to in the text.

In its revised form, Dr. Washington's book still retains its lucid, conscientious, and authoritative style and can be unhesitatingly recommended as one of the best works on this particular subject.

C. Stansfield Hitchen.

Living Africa. A Geologist's Wanderings. By Bailey Willis. Cloth, octavo, 320 pages, illustrated. Price 20s. London : McGraw-Hill.

The book under review is a description in a popular style of the author's travels in the " rift valleys " of East Africa. These

were undertaken under the auspices of the Carnegie Institution expressly in search of the origin of the unique land forms of this area. This abstruse question does not lend itself readily to popular treatment, but the author has produced a very readable account of his wanderings and musings in East Africa. The book describes his journeys during five or six months through Kenya, Tanganyika, part of the Belgian Mandated Territory and into Northern Rhodesia.

The remarkable topographical structures of Palestine, Jordania, the Red Sea, and East Africa have ever excited the curiosity of travellers and geologists. For many years the views expressed by Professors Suess and Gregory, that these rift valleys were the result of tensional earth-movements and gravity received general acceptance. In 1920 after a further examination of a part of the area, the latter re-iterated his views on the tensional origin of the rift valleys. This met with criticism; Dr. Ball citing evidences of compression in the Red Sea area, and even questioning the tectonic origin of these land forms. A paper by Mr. Wayland on the "Rift Valleys of Lake Albert" followed in 1921, in which the compressional nature of earth-movements in that region was demonstrated, and a theory of origin of rift valleys advanced that they were the result of stepfaulting in over-thrust strata. About this time Dr. Wegener cited the East African "rift valleys" as examples of the operation of continental drift. Three years ago the reviewer, after detailed mapping of an extensive area along the coast of Kenya, and reconnaissance over large tracts in the neighbourhood of the rift valleys, emphasized that the rocks of East Africa furnished widespread evidence of having been subjected to compressional earth-movements of considerable intensity. In view of this it was pointed out that the tensional theory of origin of the rift valleys was untenable. These views were criticized on the grounds first that the faults on the coasts were not over-thrusts and secondly that those in Uganda and Tanganyika were formed prior to the tensional movements, which are supposed to have given rise to these land forms.

Dr. Willis opens his book with a prologue in which he reviews the ideas of Suess and Gregory and the later work of Wayland. He leaves the reader in no doubt that the rift valleys are tectonic features, and that uplift and compression have played a considerably greater part than tension and gravity in the displacement of the earth's crust. He cites numerous widespread examples of thrusts of high and low hade and of considerable intensity and definitely rules out the application of the continental drift theory. The conclusions advanced as to the cause of the forces which have affected the earth's crust in the region of East Arrica are startling in their simplicity and ingenuity, but there would appear to be considerable difficulty in the securing of field evidence to substantiate them.

The greater part of the book describes, in a light style, the journeyings and musings of the author on the various land forms met in his travels and there are many interspersions of the lighter episodes of the tour.

Opinions disagree as to the popular treatment of scientific subjects, but it will be agreed that if so treated they should be published at popular prices, in order to command as wide a circulation as possible. The price of the present issue will considerably restrict its distribution in this country. The illustrations are not particularly well chosen and certainly not very well reproduced. Otherwise the book is well and clearly printed, though a few typographical errors have been overlooked, especially in the earlier chapters. The question of maps in East Africa is always a difficulty, and except for the one on page 57, the author's maps leave very much to be desired. It is a book that will be read with pleasure by all interested in land forms and their origin, and more especially by those intimate with the areas described.

ERNEST PARSONS.

General Stratigraphy. By J. W. GREGORY and B. H. BARRETT. Cloth, octavo, 289 pages, illustrated. Price 10s. London: Methuen & Co.

This book, designed "for use by students and reference by engineers," gives briefly the principles of stratigraphy, summarizes the British rock-succession system by system, and describes the foreign equivalents. The Herculean task of collecting such a mass of facts and arranging them in such an interesting manner, is equalled only by the attempt to squeeze them into 239 pages. Imperfections in such a work are probably inevitable, although careful revision would have eliminated some. Thus, whilst many deposits of economic value are mentioned and indexed,

no reference is made to the Spitzbergen and Polish coalfields which supply most of Scandinavia's coal consumption, or to the Kimberley diamond pipes. The tabulated appendix of stratigraphical names is useful, but here again revision would have excluded such faith-destroying statements as that the Cenomanian is "L. Cret.," Dittonian is "Up. Dev." or "Up. O.R.S.," Etcheminian is "L. Carb.," Longmyndian is "L. Camb.," Visean is "M. Carb." or "Moscovian." The illustrations include 9 maps of hypothetical world palaeography and a few curiously chosen and carelessly made line-drawings of fossils.

C. J. STUBBLEFIELD.

☞ 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

February 18.

Mount Isa Activities.—Reports from the local mining warden and inspector of mines for January indicate that development work on the Mount Isa field, North Queensland, is still progressing satisfactorily. The "pocket" in the main haulage (Urquhart) shaft had then been taken to a depth of 120 ft., and was expected to be finished in a short time. The west drive from the main haulage shaft was in 919 ft., but at this point driving was stopped on account of an influx of water, pending the completion of preparations for dealing with it in the main haulage sump. The south drive, in about 800 ft., will meet the north drive from Lawlor's (Rio Grande Lode) in a further 1,100 ft. of driving. The flow of water in the man and supply shaft is now under control and work has probably been resumed in Davidson's shaft on the Black Star lode. In the boring campaign, during the fortnight ended January 10, 99 ft. of drilling was done at bore-hole 4C on the Black Star lode, and the hole has been completed to a depth of 1,657 ft. This plant has been dismantled for re-erection at the site of bore-hole 2C. Other underground work in the same period totalled 176 ft. of sinking and raising, together with 555 ft. of driving and cross-cutting. On the surface, the main power-house and compressor plants have been finished and the temporary compressor plants at the supply and Lawlor shafts shut down. The d.c. generator was changed from steam to electric drive on January 9, while the Urquhart shaft pumps have been put on the power-house line. The new General Manager at Mount Isa (Mr. J. Kruttschnitt), interviewed the other day, said that the company expected to start production about April 15 and that it would gradually increase the quantity of ore treated until it reached 1,500 tons a day. Then, as conditions warranted, this figure would be increased until 2,000 tons daily was dealt with. Underground the two main shafts, he affirmed, are practically clear of water, and work is progressing very favourably. Mr. Kruttschnitt also said that the Australian employees at the mine impressed him as willing workers, with the disposition to give a fair return for a fair wage, and that he does not anticipate any industrial trouble in the future.

Cloncurry Copper.—Notwithstanding the continued low price of copper, a fair amount of ore continues to be sent monthly from the Cloncurry district, North Queensland. The great bulk of this now goes to the Chillagoe State smelters, further North, instead of to the Port Kembla works in New South Wales, as formerly. As stated in the lately issued yearly report from the Mount Elliott Company, it has been decided to continue to work its mines in this district on tribute. The richest and most important of the mines is the Mount Oxide, about 80 miles north-west of the railhead at Dobbyn. Here the mine is producing ore which goes as high as 40% in value and its contribution to the total despatched from all the company's leases is not only the greatest in bulk, but is so rich that it puts the average value of all the ore at 21%. The Mount Elliott Company in its last financial year received £10,873 as royalty from its tributers in the Cloncurry field, the result of the production and sale of 7,933 tons of ore, yielding copper worth £70,674. The next contributor in importance to the Mount Oxide is the Trekelano, a privately-owned mine near Duchess. From this holding in December there was despatched nearly 400 tons of ore, despite the fact that the mine closed down on the 15th for the Christmas holidays.

Other Cloncurry Minerals. — The minerals occurring in the vast Cloncurry belt now include, beside the immense lead-silver-zinc deposits of Mount Isa and extensive copper resources, gold, cobalt, mica, and bismuth. The mineral returns from the district for December included parcels of cobalt ore from two mines—the Mount Cobalt and the Success. A new product from the

field is a parcel of bismuth-copper-gold ore sent to Charters Towers for treatment as a test. The bismuth and copper were in carbonate form, with a siliceous ironstone and quartz as the predominant minerals in the gangue. Owing to the peculiar composition of the ore and its amenability to amalgamation and wet gravity treatment, this test parcel received special attention. The result of the treatment was described by the district inspector of mines as fairly satisfactory. At the same time, it is pointed out that the experience gained in the treatment will be useful as a guide for improving the recovery from future lots of the ore. With regard to the recently reported new silver-lead deposits near Mount Isa, the discoverer (Mr. P. Black) reports that he has sold the leases held by himself and two others to a Brisbane syndicate and it is stated that no time is to be lost in exploiting the find. Two miners who have recently returned from a prospecting tour have reported the discovery of gold within ten miles of Cloncurry. The first loading of ore was 9 tons, which averaged 2½ oz. to the ton and which, it is said, will average £10 a ton in value.

Oil Prospecting.—The Federal Government has announced that, owing to the existing financial stringency in Australia, no money can be made available as subsidies for companies engaged in the search for oil. The technical knowledge of the Geological Adviser (Dr. W. G. Woolnough) and his staff, however, will be made available to all interested in the search. News from Sydney is to the effect that Oil Search, Ltd., in its bulletin for February, states that Dr. Woolnough is of opinion that Australia, by adhering to proved methods consistently and scientifically followed, will establish an oil industry and should, if given scope, do this within the next two years. It is the aim of this company to develop that practice and it is stated the company at present is virtually in a position to deal with four test wells on the fields in which it is operating.

Jervois Range Field.—At the close of 1929 a rich find of minerals was reported from Jervois Range, in Central Australia. The locality of the discovery is 100 miles from Urandangie, in Queensland, and 210 miles from the terminus of the Central railway at Alice Springs. Early glowing reports were somewhat discounted by those subsequently made, which latter specially laid stress on the problems of transport and of water supply for mining purposes. Early last year, however, the Hanlon's Reward (Jervois Range), Ltd., was formed and started work to prove whether the ore-bodies discovered lived downward. Three shafts were sunk to 100 ft. One, on the lowest position, struck water level at 95 ft. and, on cross-cutting 32 ft. in ore, the values were 10% copper, with 1½ dwt. of gold and 15 oz. of silver per ton. Further particulars have been given by one of the directors of the company (Mr. T. B. Crosbie), who was in Brisbane the other day, returning from Melbourne to the field. He says that the field, which lies about midway between Mount Isa, North Queensland, and Alice Springs, consists of two parallel lodes, about six or seven miles in length, and varying in width from 10 ft. to 160 ft. One lode carries copper, assaying as high as 33·4%, with 14 oz. of silver to the ton. The other carries silver-lead, assaying 100 oz. of silver to the ton and 50·85% of lead. Mr. Crosbie adds that it has been definitely proved that the values exposed are sufficient to justify inspection by mining interests with a view to a merger or the investment of adequate capital to bring the properties to a payable production stage. It is further stated that good water is now available in shafts and wells, while there is no scarcity of mining timber and firewood.

Australian Coal Trade.—As far as Queensland is concerned, nothing has yet been settled with regard to the proposed reduction of wages in coal mines and consequently the trade in this State is going from bad to worse. It is now some months since, on the resumption of work in the principal collieries of New South Wales after a prolonged stoppage, lower rates of pay were accepted, and the selling price of coal was reduced by several shillings a ton. Nothing in this direction has been finalized in Queensland, mainly, it would seem, because the associated mine owners and those not associated cannot agree. This is no doubt why the demand for Queensland coals becomes less and less. The directors of the Bowen Consolidated Company, owning the mine adjoining that of the State, complain, as a reason for the dwindling of its trade, that the Government Railway Department is giving all its orders to the State mine, although the Consolidated quoted rates which they believe were the lower; also, that in other respects the company is meeting with what the directors consider is unfair competition from the State mine. In New South

Wales the Lang Government, controlled by extremists in the Labour party, has prepared a bill " for the reorganization of coal mining," which will, if passed, make drastic changes in the conduct and control of the industry in that State. In the present nebulous condition of politics and administration in New South Wales, no one can say whether this measure will even pass the legislature. As drafted, the bill, which seeks to give effect to the socialization policy of a section of the Labour party, provides, primarily, for the constitution of a board of three members, who will be empowered to close down mines, as well as to regulate the prices of coal and the number of employees to be engaged in the industry. Amongst other powers to be conferred on the board are those of taking into account, in fixing the price of coal, the efficiency or inefficiency of mining management and equipment; of inquiring into the subject of profits in relation to capital; of closing down certain mines permanently or temporarily, assessing the compensation to be paid to the owners; and the fixing of the profits that shall be allowed to the proprietors.

TORONTO

March 16.

Mineral Production in Canada in 1930.—The mineral production of Canada for 1930 was valued at $278,470,563, a decrease of 10% as compared with the output of 1929, which was valued at $310,850,246. The value of the metallic production was $142,949,293, as compared with $154,454,056, the decrease in value being due to the drastic reduction in metal prices during the year. More gold, copper, zinc, silver, and lead were produced than during previous years. Non-metallics which decreased in quantity and value were coal, asbestos, gypsum, salt, clay-products, cement, and lime, but the output of petroleum was largely increased.

Porcupine.—The production of bullion in the Porcupine gold area during February was valued at $1,608,289 from 230,732 tons of ore, as compared with $1,572,676 during January from 252,324 tons treated. Hollinger Consolidated continued well in the lead, other mines in order of production being McIntyre, Dome, Vipond, Coniaurum, March, and Porcupine United. The Hollinger is steadily carrying forward its programme for deeper mining, involving the sinking of a shaft to a depth of 6,000 ft. Ore values obtained in recent operations on the lower levels are somewhat higher than on the upper horizons and an unofficial statement is published to the effect that commercial ore has been encountered by diamond drilling at a depth of 7,000 ft. or some 3,000 ft. below the present workings. The old shaft in the western part of the property has been unwatered and is being deepened. The Coniaurum during 1930 treated 122,927 tons of ore with a recovery of $773,455, the operating profit being merely sufficient to cover the cost of exploration and development. The shaft will be sunk as a part of the programme to locate larger tonnages or higher values. Operations at the March have not realized returns sufficient to cover operating costs. During 1930 gold was produced to the value of $306,000, from the treatment of 54,000 tons of ore; a recovery of $5·66 per ton. The prospect of profitable operations depends on a moderate increase in the grade of ore or the treatment of a larger tonnage. The mill is treating 150 tons daily.

Kirkland Lake.—The producing mines of this field during February yielded bullion valued at $1,564,538, from the treatment of 116,536 tons of ore, as compared with $1,649,434 produced from 128,477 tons in January. The Lake Shore has encountered high gold values in development work on the 2,200 ft. level. The width of the drive on this level is from 8 to 9 ft. wide. The average assay of all ore extracted from 315 ft. of driving was $43·52. The Wright Hargreaves has been encouraged by the improvement shown below the 2,000 ft. level, where vein matter became more regular and dimensions increased, to undertake a campaign of deeper mining. It is the intention of the management to deepen the shaft to 3,000 ft. and to open up four new levels. Teck-Hughes is maintaining a production average of around $500,000 monthly. A large proportion of ore from the lower levels is understood to average $18 to the ton. The mineralized zone at 3,600 ft. in depth is reported to be about 80 ft. in width, with varying values suggesting an average of $20 per ton over the entire width. A new 300-ton mill unit is nearing completion, and expected to be ready for operation by the end of this month. At the Kirkland Lake gold mine the high gold content of ore drawn from the lower levels has brought the millheads up to $12 a ton. High grade values are being encountered on the 4,300 ft. level, where driving operations are being carried out to determine more fully

the extent of the mineralized zone. The Telluride is carrying on stoping operations on the 250 ft. level where the ore shows improvement over that on the upper level. Cross-cutting is under way on the 150 ft. level to cut the vein which had dropped out of the shaft. The Barry-Hollinger during 1930 produced $218,025 from the treatment of 31,725 tons of ore with an average recovery of $6·87, the revenue being sufficient to pay all costs. The winze will be continued to the 1,875 ft. level, at which cross-cutting will be undertaken. A new electric hoist is being installed which will enable the workings to be carried to a greater depth. The Moffatt Hall is preparing to resume operations and will sink a shaft to a depth of 200 ft.

Rouyn.—The annual report of the Noranda Mines, Ltd., for 1930, shows that the smelter treated 733,971 tons of ore, concentrates, and siliceous ores used as flux, and produced 76,142,246 lb. of blister copper as compared with the production of 51,626,478 lb. in 1929. The ore reserves were estimated at 8,175,000 tons compared with 6,664,000 tons. The gross income from metal recoveries totalled $11,967,472. Operating expenses were $6,284,930, leaving operating profits of $6,133,833. After deducting $3,919,601 for dividends, there remained a surplus of $3,890,115. The Waite-Montgomery is maintaining active development and steadily increasing its ore reserves. Ore has been encountered along the main fault from the surface to the 1,000 ft. level, and the plan of operations is to explore the extent of this known ore-body, and open up other sections of the property. The Aldermac Mines, Ltd., will erect a 500 ton concentrator at an early date, there is a sufficient supply of ore for several years, which contains 60 to 70% pyrite and 2% copper. The separation of the sulphur content from the pyrite will enable the company to engage in the production of sulphur. Results of development at the Granada Rouyn gold mine have so far been highly encouraging. The 16,000 tons already treated having given an average recovery of about $14 per ton. The workings will be carried to greater depths. The annual report of the Siscoe gold mine for 1930 shows that 33,744 tons were milled with a recovery of $11·11 per ton. Production amounted to $367,265 and operating cost to $243,973, leaving a profit of $123,293. The Pandora gold mine is installing a mining plant in order to undertake development on a large scale. A three compartment shaft will be put down to a depth of 500 or 600 ft. as the first objective. The ore zone on Pandora has been traced for a distance of 6,000 ft. in length and diamond drilling has indicated ore carrying $12·20 to the ton.

Sudbury.—The annual report of the International Nickel Company of Canada for 1930 showed a net profit of $11,770,060 after deductions for depreciation, depletion taxes, and other reserves, as compared with $22,235,996 for 1929. Sales of nickel in all forms including alloys amounted to 75,284,352 lb. as compared with 125,577,789 lb. Sales of copper were 109,743,747 lb. as against 81,983,776 lb. in 1929. During the year capital expenditures, incident to the development of the Frood mine and construction of accessory plants, and to programme of additions and betterments in England, were practically completed at an aggregate cost of $12,328,918. As regards the outlook, the report pointed out that the immediate prospects of the company naturally depended on the gradual return to normal conditions in the world's industry generally. Over a period of years the increase of business would be determined primarily by the expansion of the uses for nickel and nickel alloys and the experience gained in recent years gave promise that the expansion would be continued. The company is now arranging to put on the market a new monel metal sink, which in the past has been available only as a customs-built installation. Nickel copper production at the Falconbridge Nickel Mines is again on a regular schedule, and shipments are going forward to the refinery in Norway. The addition to the smelter has been completed, but will not be put into operation until additional power is available. The ore going to the smelter is being obtained from the 250 and 375 ft. levels. A small mining plant is being taken into the Foy township property of Sudbury Offsets, Ltd., preparatory to putting down a shaft to the depth of 300 ft. A large tonnage of medium grade nickel-copper mineralization has been indicated by diamond drilling.

Manitoba.—The first unit of the mill of the Sherritt Gordon with a capacity 600 tons has gone into operation, though working below capacity. As new units are added production will be gradually stepped up. The concentrates will be shipped to the Hudson Bay Smelter. The smelter of the Hudson Bay Mining and Smelting Company is treating 3,000 tons daily and shipments of blister

copper are going forward at regular intervals. The greater part of the ore going to the smelter is from the huge open-pit, formerly the bed of the Flin Flon Lake. An encouraging feature is that the gold content of the ore is about $1 a ton more than originally expected, which with the large tonnage treated will make a substantial difference in the returns. The Central Manitoba Mines, Ltd., during 1930 produced $395,382, from 46,872 tons treated, with a recovery of $8·44 per ton. Current production is about 133 tons daily, from which is recovered approximately $9 per ton.

Canadian Institute's Annual Convention.—The 32nd annual convention of the Canadian Institute of Mining and Metallurgy was held at Ottawa on March 4–6, with an attendance of 300 men representing every province in the Dominion. An address of welcome was delivered by Hon. W. A. Gordon, Dominion Minister of Mines, who spoke on the importance of the mining industry as a source of national wealth and a stabilizing influence during the period of depression which was now passing away. Dr. J. S. DeLury, Mining Commissioner of Manitoba, and the retiring president, in his annual address reviewed the growth of the Institution since 1898. The Bruce Gold Medal, which is given annually to the person making the most noted contribution in the field of practical mining, metallurgy or geology, was awarded to Horace Freeman of Montreal for his invention and development of a pyrite burner. During the three days of the convention a large number of technical papers were presented and the meeting was brought to a close by a banquet at which Hon. W. A. Gordon was the chief speaker.

VANCOUVER

March 11.

Consolidated Gold Alluvials of British Columbia.—A company, with a board including representative business men of Vancouver, supported by English capital, has been formed to acquire and develop the properties of the Lightning Creek Gold Mines, Ltd., together with those of La Fontaine mine. The two properties cover a total length of about 22½ miles on Lightning Creek and the company which has been incorporated to take them over is known as the Consolidated Gold Alluvials of British Columbia, Ltd. The capital is $2,500,000, in shares of one dollar each, of which 300,000 shares are under a two year option at $1·50 each to the Lightning Trust Co., and 1,700,000 will be allotted as fully paid up in settlement of the respective purchase considerations. The remaining 500,000 shares are offered for public participation at par.

Those responsible for the prospectus make use of the same weapon of exaggerated statement that was employed by those who formerly directed the fortunes of the old Lightning Creek Gold Mines. In view of the fact that the venture is in itself a legitimate one and offers considerable speculative possibilities, it is unfortunate that the prospectus subjects a justifiable undertaking to suspicion before it is properly launched. The prospectus features a report by Mr. David Melvin, who is described as "a successful Deep Lead Mining Engineer." Mr. Melvin makes the startling assertion: "I am satisfied that the values of gold contained in this section of Lightning Creek are phenomenal and, basing my estimate on the evidence of boring results of No. 6 Section and assuming—which is quite reasonable—that the other sections are similar, there are probably gold contents of 50 million pounds in the 21 miles of creek owned by the company." If this is the case the Creek is anticipated to yield many times the amount of gold that has been won from the whole Caribou district, and also from the unglaciated Klondike placer area to date. On the following page of the prospectus one reads: "In the absence of drilling results over the full length of the company's property the board considers it inadvisable to give any estimate of the total gold contents." And again: "The gold content of the 5,000 feet (Section 6) bored are calculated at the conservative figure of 10 pounds (sterling) per cubic yard over an average width of 60 ft. and a depth of 6 ft." This works out at $660 per running foot, as compared with Mr. Melvin's vision of $2,200 per running foot.

Britannia.—The annual report of the Howe Sound Company for the year ending December 31 last contains statements of local interest with reference to Britannia. The reduction of costs in all operating departments were material to a considerable degree in off-setting the marked decline in metal prices. At the same time it is remarked that while further appreciable savings have been made, the curtailment in reduction of copper inaugurated late in the year constitutes a further handicap which will be

reflected in the company's earnings until more stable price conditions prevail. Development work at Britannia has resulted in opening further extensions of known ore deposits. The installation of new mechanical devices and the adoption of revised metallurgical processes have the effect of increasing milling capacity and improving metal recoveries. The company's operating surplus for the year amounted to $2,030,291·88, the earnings per share being $4·09.

Portland Canal.—The Premier Gold Mining Company has acquired a substantial interest in the Toburn Gold Mines, Ltd., a company recently formed to take over the option on the Tough Oakes-Burnside mines at Kirkland Lakes, Ontario. The acquisition by the Premier Border company of two groups of claims on Mt. Olie near Kamloops is announced in a progress report to shareholders. Work on the company's property in the Portland Canal District has been suspended for the meantime.

Central District.—The most important event of the month is the entry of the Pioneer amongst the dividend paying mines of the Province. The initial dividend is at the rate of three cents a share for the quarter ending March 1.

The lower Bridge River Placers, Ltd., holding placer claims and leases on the lower Bridge River, proposes exhaustively to test the ground in contemplation of dredging it, after the B.C. Electric Railway Co., Ltd., has completed its dam, the effect of which will be the shutting off and diversion of the stream so as to render mining operations feasible, if other conditions prove favourable.

Boundary.—Interesting developments are reported in this district. One of the old properties in Long Lake known as the Jewel Mine has been consolidated with a number of adjacent claims. The Jewel was worked for many years, and produced a considerable quantity of gold. Operations have been suspended since 1914. A new company, the Dentonia Mines, Ltd., has been organized to operate the consolidated properties and to carry out the terms of a bond. This requires that the commencement and construction of a 50-ton cyanide plant on or before September 1931.

The Hecla Mining Co., owners of the Union Mine, makes the following reference to the property in its annual report: "Production continued at the Union Mine in British Columbia. The ore-body is small and will be exhausted in 1931 unless other deposits not now known are disclosed. We are making an operating profit from this property, but from the present indications the venture will result in a loss. The small tonnage coupled with the low silver price, will complete return of the capital invested."

West Kootenay District.—A plan which contemplates the issuance of first mortgage notes to the value of at least $10,000 in connexion with the reorganization of the Kootenay-Florence, has been tentatively approved by the directors. It is proposed that the new company be formed with a capital of $1,000,000 in 4,000,000 shares of par value of 25 cents each, of which approximately 1,000,000 shares will be exchanged for stock in the present company at a ratio of one for six. Subscribers to the note issue will have right of conversion into stock at the ratio of 15 shares for each dollar. The plan will leave 1,500,000 shares in the treasury for future development, retire all obligation of the old company, which aggregates about $50,000, and leave a balance on hand of approximately $50,000. Over $25,000 has already been subscribed to the note issue. A minimum of $75,000 must be subscribed to make the plan operative. The company's property at Ainsworth has been developed at a cost of over $400,000 in the past three years, mainly through a long lake-level crosscut, which intersected the ore-bodies at a point 3,700 ft. from the portal, and a further depth of 550 ft. at the dip of the vein. It is estimated that there was a three years' supply of lead-zinc-silver ore in sight at the time work was suspended due to bankruptcy of the underwriters.

West Kootenay Power.—The net earnings of this company during 1930 were $1,885,180 as compared with $1,685,154 in 1929. The productive capacity of the company has been produced steadily and at the present time three hydro-electric plants are operated on the Kootenay River, having a total installed capacity of 167,000 h.p. The company will presently have under construction a unit at Corra Linn, which will have, upon completion an installed capacity of 57,000 h.p. West Kootenay has plans under way for the development of 30,000 h.p. on the Adams River, 35 miles north-east of Kamloops. The power requirements of the Okanagan district and contiguous territory will be supplied from this source.

JOHANNESBURG

March 11.

Diamond Mining Returns for 1930.—Very serious decreases in production, sales, and prices are shown by the official diamond mining and digging returns for 1930. The principal totals for the last two years are :

	1930	1929
Carats won	3,163,590	3,661,211
Estimated value	£8,340,719	£10,590,113
Carats sold	1,892,954	3,082,016
Value	£5,979,880	£12,426,462
Price realized per carat	63s. 2d.	30s. 8d.

During the year 1930, 51¼ carats of diamonds, worth £47, were produced from the Witwatersrand area—47¼ carats were found in gold mines and 4 carats were produced from alluvial deposits.

Rouxville Gold Discoveries.—The excitement in the Rouxville and Zastron districts, Orange Free State, caused by discoveries of pieces of gold-bearing rock, appears to be diminishing. Mr. J. D. Marquard, Commissioner of Mines, is reported to have said that he has failed to find any gold reef in the Rouxville-Zastron region. Dykes of gold-bearing quartz are to be seen at various places, but he doubts whether it will pay to work these deposits. Mr. Marquard strongly advises farmers in the district to forget about the gold discoveries and to attend to their farming.

Bartoli Process.—Dr. Bartoli, the Italian chemist, who is reported to have obtained very encouraging results with his process for the extraction of gold from the refractory Black Reef at one of the old mines about two miles south of Johannesburg, is transferring his plant and machinery to one of the old Main Reef mines, the Wolhuter, where further and final investigations will be made. It is stated that the process is now passing from the experimental stage to the treatment of ore on a large scale.

Rand Development Statistics.—Over 240 miles of tunnelling was done on the Witwatersrand fields during 1930. The great Crown Mines property was further honeycombed by no less than 128,056 ft. of tunnelling, compared with 91,066 ft. during 1929, which was considered no mean feat at the time. Quite apart from the tremendous cubic ore space stoped out, during the year there was also 42,685 yd. of shaft sinking, haulage ways, drives, winzes, raises, and chambers for machinery bored through solid rock. In the smallest of these tunnels an average man can stand upright and extend his arms without touching both faces of the cuttings. The total footage so drilled and blasted on all the gold mines of the Witwatersrand during the year closely approximates 1,280,000 ft., or 42,666 lineal yds.

Prospecting Party at Matsap Pan.—A prospecting party under the direction of Mr. J. Temple, an American engineer, has commenced operations at Matsap Pan, an extensive salt lake lying among the Langeberg Hills, some 30 miles south-east of Postmasburg. Matsap Pan differs from most South African salt pans in that its saline deposits contain a variety of compounds in considerable quantities, the most interesting being sodium nitrate, along with common salt and magnesium, sodium, and calcium sulphates. Attempts in the past to extract the nitrate on a commercial scale have failed.

Proposed New Manganese Company.—Agreements have been signed which provide for the formation of a company to work the manganese deposits on the farm Gloucester, which lies well within the Postmasburg manganese belt. Favourable contracts have been entered into on a royalty basis with the owners of the farm, the Gloucester-Manganese Company, on the one hand and with consumers of manganese overseas on the other. The latter contracts provide for very large shipments of ore. The Gloucester property is situated about 14 miles from the new railway to Postmasburg and it will be necessary to link the property to the latter by an aerial railway or a narrow gauge line.

Manganese in Natal.—A prospector reports that deposits of high-grade manganese ore have been discovered in Natal within 200 miles of Durban. Samples of the ore have been assayed in Johannesburg and are said to have shown a manganese content of 50 to 60%, equalling the value of the best Postmasburg ore. The Natal deposits are situated on Crown land within 20 miles of the railway.

Platinum Production.—Government statistics show that within a little over five years the Transvaal has produced and sold over a million pounds' worth of platinum group metals. The production per annum up to the end of last year was as follows :—

Year.	*Oz.*	*Value.*	*Value per oz.*
1926	4,951	£93,307	£18·84
1927	10,431	144,191	13·73
1928	17,827	241,110	13·53
1929	21,607	221,645	10·25
1930	41,544	299,425	7·21

A Bismuth Proposition.—An attempt is being made to raise capital for the purpose of acquiring and working the bismuth occurrence on the farm Uitkyk, Transvaal, in the Waterberg district. A consulting engineer of Johannesburg, who visited the property recently and studied the surface indications and the ore dumps, has advised the owners to unwater and repair the existing shaft in order that the value and extent of the ore-body, which is exposed at the bottom of the shaft, may be fully tested.

CAMBORNE

April 2.

East Pool and Agar.—This continues to be the only mining company in Cornwall in active operation. February's crushing was 2,619 tons, against 2,976 in January. The recovery was improved by 3·92 lb. of black tin per ton to 35·16 lb. as against 31·24 lb. in the preceding month. This approximately counterbalanced the lessened tonnage, as February's receipts amounted to £2,988, as compared with £3,097 in January. The tin sales were 41·5 tons and 41·1 tons respectively in January and February; and the arsenic sales 20 tons and 10 tons. The tonnage contents value for February was £1 2s. 10d., an increase of 2s. a ton on that for the preceding month.

Tehidy Minerals. — Strictly speaking, Tehidy Minerals is not a mining company, since the company conducts no mining operations, but it is the owner of extensive mining rights in Cornwall, having been formed in 1919 to acquire, from Mr. Basset, the mineral rights of the Tehidy Estate, except those relating to Dolcoath and East Pool, rights which had been acquired by those companies. Later in the same year practically the whole of the mineral rights of the Lanhydrock Estate were acquired from Viscount Clifden, a small exception having been made in respect of the parish in which Lanhydrock Mansion stands. The purchase included extensive china clay rights. Since the formation of the company there have been two periods of severe depression in Cornwall's mining industry, that of 1921–23, and that which the industry is at present experiencing. Notwithstanding depressions, however, moderate dividends have been earned in several years, including that just past, 1930.

Restriction Scheme.—The definite establishment of the Governmental scheme for control of production has strengthened confidence in the future of the mining industry in Cornwall, and a more hopeful feeling prevails.

PERSONAL

R. J. Agnew is leaving for Italy.

R. A. Archbold is returning from Bulgaria.

A. L. Austen has left Tanganyika for France.

W. J. Bannister has left for Peru.

Arthur J. Bensusan has left for Brazil.

Juan D. Falconer is returning from Uruguay.

E. Furze is home from Mexico.

W. H. Geikie is returning from Sumatra.

A. G. Glenister is returning from Malaya.

J. K. L. Graham has left for Western Siam.

T. C. F. Hall is home from Yugoslavia.

Donald Hinton is returning from Nigeria.

P. Mercer Hume is home from the Gold Coast.

C. E. Jordan is home from Tanganyika.

R. J. Lemmon is leaving on a short visit to South Africa and the Rhodesias.

F. W. Maclennan, general manager of the Miami Copper Company, has been presented with the Saunders Gold Medal of the American Institute of Mining and Metallurgical Engineers.

J. H. McLean has left New Jersey for Sudbury, Ontario.

Dennis Renouf is returning from Nigeria.

J. F. W. Rowe is home from Nigeria.

O. B. Soskice has returned from Northern Rhodesia.

F. A. Cutten, of Cutten Brothers, Dunedin, New Zealand, died on April 6, aged 76.

Robert Woodward, who for many years was chairman of Edgar Allen and Co., the Sheffield steelmakers, died on March 12 at the age of 88.

TRADE PARAGRAPHS

Ropeways, Ltd., inform us that on and after March 23 their address will be 152/6, Great Portland Street, London, W. 1.

W. H. Allen, Sons, and Co., Ltd., of Bedford, are exhibiting at the Buenos Aires exhibition a light weight single-acting airless-injection vertical oil engine of which the fuel consumption figures on a full load are 0·39 lb. per b.h.p. hour.

Mavor and Coulson, Ltd., of 47, Broad Street, Glasgow, have issued particulars of the "Samson" chain coal-cutter improved haulage, which is now supplied with high and low speed controls that are thrown out of gear instantaneously.

Drysdale and Co., Ltd., of Glasgow, are showing at the Buenos Aires exhibition a number of centrifugal pumps, notably a 14 in. pump which will discharge 3,000 gallons per minute against a total head of 27 ft. when running at a speed of 960 r.p.m.

Agricultural and General Engineers, Ltd., of Aldwych House, London, W.C. 2, are exhibiting at the British Empire Trade Exhibition at Buenos Aires. Their exhibits include a Davey Paxman twin-cylinder vertical oil engine of 70 to 77 b.h.p., also examples of Blackstone spring injection oil engines.

Denver Equipment Co., of Denver, Colorado, send us a booklet describing conditioning and agitating in connexion with flotation concentration.

This covers some 20 pages which are fully illustrated with diagrammatical sections and machine drawings, and contains much useful data concerning minerals and their characteristics, pulp density tables, etc.

Mining and Industrial Equipment, Ltd., of 11, Southampton Row, London, W.C. 1, report that new orders have been received for the following equipment: For England: One 3 ft. by 5 ft., type 39, Hum-mer screen for fireclay and one No. 00 Raymond pulverizer for ochres. For Brazil: One 3 sq. ft. Rovac filter for ore experiments.

Adam Hilger, Ltd., of 24, Rochester Place, London, N.W. 1, issue bulletins devoted to the cubic crystal analyser which is constructed for use with the X-ray crystallograph, and a bulletin describing that instrument, which is a new development. This serves for the identification and study of the structure of crystalline substances, including many powders, etc., not usually regarded as crystalline, by means of the diffraction from the various planes of the crystal rich in atoms.

Third International Drilling Congress.—This will be held at Berlin in 1933, probably in September, previous gatherings having been held in Bucharest in 1925 and in Paris in 1929. In connexion with the Congress, there will be an exhibition of models of modern drilling appliances and tools. Further particulars will be published at a later date, but in the meantime information can be obtained from Geschaftsstelle des Deutschen Nationalen Komitees, Berlin, S.W. 68.

J. Pohlig, A.G., of Koln, Germany, issue a fully illustrated book describing their ropeway system. This gives particulars of the principle of operation and of various details such as ropes, carriers, trucks, etc., stations and special installations. Photographs of a wide variety of plants in operation in all parts of the world are included and a number of tables giving elevations of typical installations. They also inform us that **C. M. Hill and Co.,** of Coventry House, South Place, London, E.C. 2, are now their representatives for the United Kingdom.

Messrs. Crossley Bros., Ltd., of Openshaw, Manchester, issue catalogues as follows: One giving abridged particulars of their vertical compressorless Diesel engines, which are built in two sizes of cylinder and in two to six cylinder units with horse powers of 60 to 400 b.h.p.; one devoted to their new design of small horizontal Diesel engines made in sizes of 9, 11, 13, and 15 b.h.p. which were referred to last month in connexion with their exhibit at the British Industries Fair; and a pamphlet giving brief particulars of all their major oil engine products.

Rapid Magnetting Machine Co., Ltd., of Lombard Street, Birmingham, send us a leaflet describing the electro-magnetic belt-bucket elevator-separator which is an entirely new departure and which has been built with a view to combining a magnetic separator with a belt-bucket type elevator in a single unit. The advantages are that the height of the elevator need not be increased in order to feed a magnetic separator as a separate unit, as is usually the case. The elevator can be any height and the separation is automatic. In place of the ordinary head pulley, a magnetic pulley or drum is substituted. As each bucket passes over the magnetic pulley it becomes magnetized and retains any tramp iron, while the non-magnetic material is automatically emptied in the usual manner. The magnetized buckets still retaining the tramp iron travel on and at a given point leave the magnetic field of the pulley, automatically becoming de-magnetized, and the tramp iron being released falls into a diverting chute. Existing elevators, if sufficient head room is available, can be converted to this new system.

Hadfields, Ltd., of Sheffield, inform us that they are staging an exhibit at the exhibition of British Empire minerals now taking place at the Imperial Institute. This consists of specimens illustrating the properties of manganese steel, which was invented by Sir Robert Hadfield in 1889. An alloy of iron, manganese and carbon is being shown which is the first alloy to be used on a large manufacturing scale. Its prominent characteristics are remarkable toughness combined with high tenacity and extraordinary resistance to wear and abrasion, as well as being non-magnetic. Apart from the uses of manganese steel with which mining men are familiar, it is also employed for railway and tramway points and crossings and was, of course, also used very largely during the war for the manufacture of helmets. Another

HADFIELD'S PORTABLE CRUSHING PLANT.

exhibit shows the composition of manganese steel, the amounts of the separate constituents being indicated by the powders in bottles. There is also a tested tensile bar of " Era " manganese steel with its stress strain diagram. This shows a tenacity of 9·65 tons with no less than 51% elongation. There is also a colliery tub wheel of this manganese steel, flattened cold by blows under a steam hammer and, finally, a hammer-hardened bar which illustrates the increase of hardness caused by cold work. The firm also informs us that they are exhibiting at the current British Empire Trade Exhibition at Buenos Aires, where their exhibits include examples of their crushing machines, track work, etc. Of special interest is a portable crushing and screening plant which is being shown for the first time and which is illustrated in the accompanying photograph, which is self explanatory, the breaker being a double toggle type having a feed mouth 16 in. by 9½ in.

Holman Bros., Ltd., of Camborne, inform us that they are exhibiting at the current British Empire Trade Exhibition at Buenos Aires. Their exhibit includes a petrol driven portable air-compressor. This is a standard " S " type machine of 160 cu. ft. displacement, but in place of the more usual road wheels it is mounted on flanged track wheels for railway work and is also fitted with traversing wheels and a lifting bale. The " H.S.B." type air motor is the smallest of a range of five and develops 4 h.p. at a speed of 1,500 r.p.m. and a pressure of 80 lb. per square inch. To enable the unique mechanism to be seen, holes have been cut in the casing of the model exhibited, giving a clear view of the interior. The three different rock drills serve to indicate that there is a Holman drill for every purpose. The 50 Pounder is well known and in many mining fields is regarded as the most useful of all hand-held machines. The SL 8 Handril is the lightest of the " Streamline " series of hand hammer drills and the SL 14 is the intermediate size of the mounted drills of the same series. The " Streamline " range is the latest of the long line of Holman rock drills, and, as they are becoming more widely known so their reputation for speed with economy is becoming more widely recognized. A number of pneumatic tools are also shown.

Oliver United Filters, Inc., of New York, and Premier House, 150 Southampton Row, London, W.C.1, inform us that during the past year cyanide slime filters of both Oliver drum and American disc type have been supplied to various gold mines in Canada, South Africa, Russia and Australia. The slime pulp to be handled by these filters varies from low gold solution content up to $8 per ton solution value, or more, and its character from clean quartz ore to quartz ore following amalgamation,

FIG. 1.—GEARED TYPE WINDER BY ENGLISH STEEL CORPORATION.

and/or concentration. In one case the ore is given flotation concentration treatment, the concentrate dewatered on filters, and after roasting these concentrates they are cyanided, filtered and washed on other Oliver filters. In another instance the ore is given flotation concentration treatment and the resulting concentrate is cyanided and given successive multiple filtering and washing on three sets of American filters. With favourable conditions existing, in one case filter feed is taken directly from the agitation tank at density of 1½ to 1 and given a single filtering and washing on Oliver filters with reduction in gold content in discharged filter cake to $0·01 per ton. In all cases there is a recognized benefit gained by increased dissolving during passage through the filter, caused by aeration of the pulp by air drawn through cake on exposed filter surface. In other instances the filters follow a single previous settlement and decantation. Cyanide slime filtration units of important size were installed during the past year by the Dome, Sylvanite, Lake Shore, Teck-Hughes, and McIntyre mining companies in Canada. The Wiluna in Western Australia is another interesting slime filter installation which goes into production soon. After dewatering pyritic flotation concentrate in one filter operation, the concentrate of high value in gold is dead-roasted and, following cyanidation, is then filtered and washed on a second filter unit of Oliver filter equipment.

English Steel Corporation, Ltd., and **Vickers-Armstrongs, Ltd.,** of Vickers House, Broadway, London, S.W. 1, have recently completed at their Openshaw works two electrically driven winding engines for South African gold mines. One of these, which is illustrated in Fig. 1, is of the geared type and has a bi-cylindro conical drum 15 ft. diameter on the outer barrels, the hoisting ropes being led by means of spiral cones to the centre barrel of the drum, which is 30 ft. in diameter. The drum is driven by means of an a.c. motor through a flexible coupling and single reduction gears. The second winder, which is illustrated in Fig. 2, is of the direct coupled type driven by a d.c. motor coupled to each end of the drum shaft by flanges. This has two cylindro-conical drums, each 12 ft. diameter on the outer barrel, and 24 ft. on the inner. One drum is keyed to the shaft, the other being loose and driven by a multiple tooth clutch operated by compressed air. Further brief details are as follows :

A.C. Winder with 15–30 *ft. Drum*

Capacity	180 tons per hour
Net load hoisted each wind	6 tons
Total weight hoisted each wind	29⅛ tons
Depth of wind	3842 ft.
Speed	2750 ft. per minute
R.M.S. h.p. of motor	2221
Peak h.p. of motor	3672
Peak h.p.—hoisting men	3731

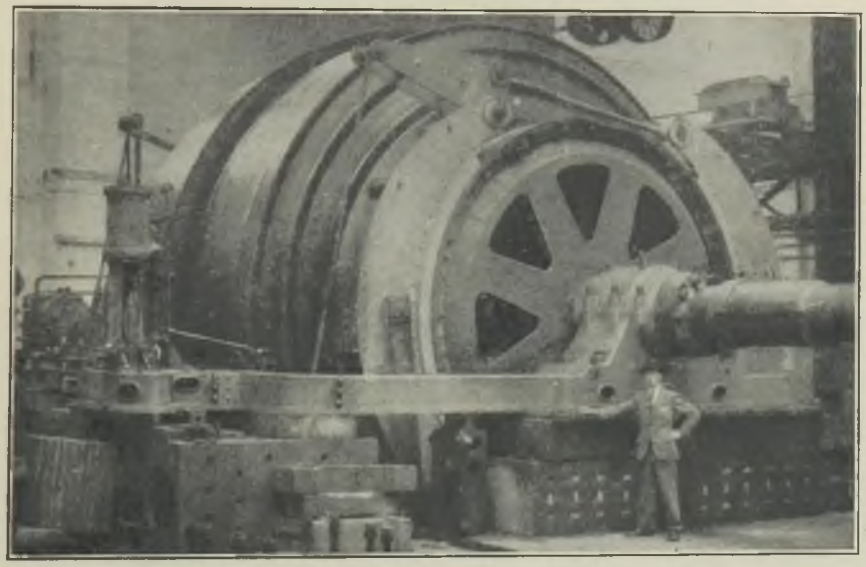


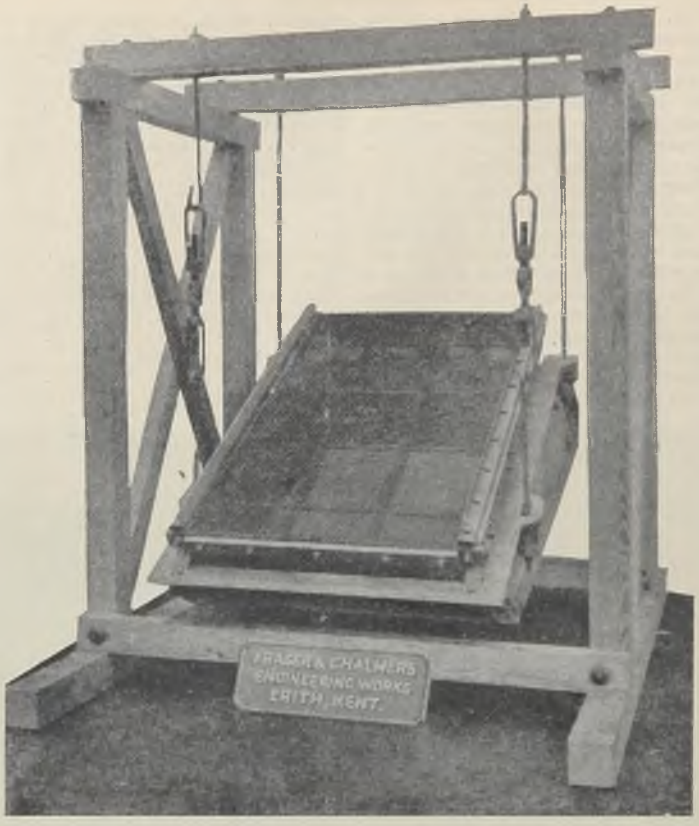
Fig. 2.—Direct-Coupled Type Winder by English Steel Corporation.

D.C. Winder with two 12–24 *ft. Drums*

Capacity	288 tons per hour
Net load hoisted each wind	8 tons
Total weight hoisted each wind	25½ tons
Depth of wind	3595 ft.
Speed of wind	3000 ft. per minute
R.M.S. h.p. of two motors	2661
Peak h.p. of two motors	4569
Peak h.p.—hoisting men	5647

FRASER AND CHALMERS "SHERWEN" SCREEN

Fraser and Chalmers Engineering Works (Proprietors : The General Electric Co., Ltd.), of Erith, Kent, have issued a pamphlet describing the " Sherwen " electric vibrating screen, which is illustrated in the accompanying photograph. It consists of a screening surface of wire mesh fixed in a moving frame of light steel construction. It is mounted on a cast iron fixed frame by means



THE "SHERWEN" SCREEN.

of hickory or ash spring slats on the Ferraris principle. The moving frame is vibrated rapidly by two solenoids mounted in a cast iron case bolted to the back of the fixed frame, the solenoids being connected together by a crossbar attached to the moving frame by two side rods. The movement of the solenoids, which make some 2,400 to 3,000 single vibrations per minute, is controlled by a make and break mechanism, and the current required is taken from the supply circuit. The make and break is regulated by a thumbscrew which enables the length and intensity of vibrations to be adjusted to suit the most efficient screening without stopping the screen. Further adjustments (which also vary the stroke and number of vibrations) can be made by means of a central buffer spring and handwheel and by altering the lengths of the side rods. Without stopping the screen, the stroke can be altered from $\frac{3}{32}$ in. to $\frac{1}{16}$ in. and the vibration from 3,000 to 2,400 per minute.

The standard screen is 3 ft. wide by 5 ft. long, single deck, and its weight is 1,800 lb. Two decks can be fitted, but for close sizing two screens in tandem are to be preferred. As there are no bearings, no pulleys and no cams, etc., and no oiling is required, little supervision is necessary. Repairs and replacements are thus reduced to a minimum. Tests on this screen have been carried out at Erith with sand, crushed stone and coal, also with various meshes of screen cloths, and its performance with these materials is shown on a number of curves published in the pamphlet.

HADFIELDS CRUSHERS

Hadfields Ltd., of Sheffield, have given us information of a large crushing installation which has now been in operation for some time in connexion with the construction of the Cauvery Metur Dam in the Madras Presidency, India, which will involve a volume of 1,852,000 cu. yd. It is believed to be the largest installation ever manufactured in this country and consists of three jaw-type primary crushers each with a feed opening of 54 in. by 42 in., 18 jaw-type secondary crushers with feed opening of 24 in. by 13 in., six disc crushers 36 in. in diameter, and six sizing screen trommels 5 ft. in diameter by 20 ft. long, together with all the necessary elevators, conveyors and other accessories. It is probably unnecessary to add that all the wearing parts of these crushing machines are made of "Era" Manganese Steel.

The large crushers, classed as sledging breakers, each weigh about 100 tons and are individually the largest made in this country. The material being crushed is charnockite, a hard granite very similar to Aberdeen granite. The large machine which is illustrated in the accompanying photograph (Fig. 1) is capable of a minimum output of 200 tons per hour.

The product from the primary crushers is 6 in. to 8 in. and under, and all over $2\frac{1}{2}$ in. is passed to the secondary crushers, the product of which, together with the undersize from the primary crushers, goes to the sizing screen where it is

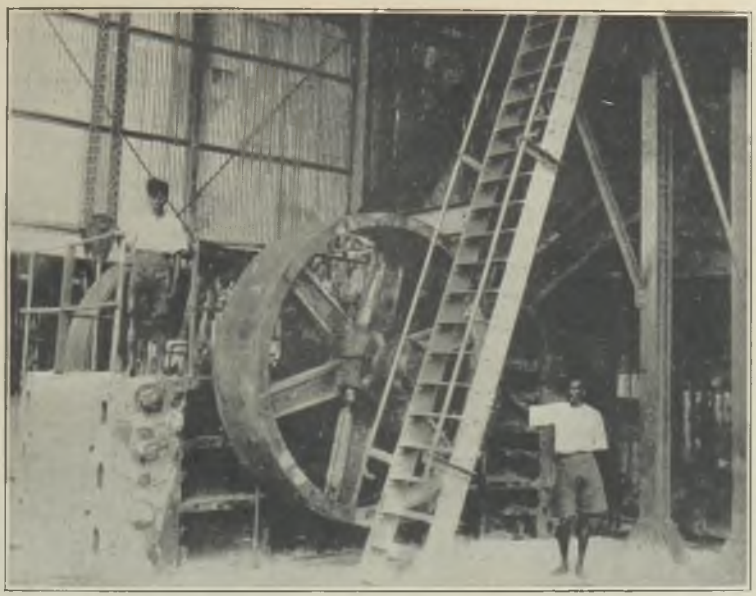


FIG. 1.—HADFIELD 54 IN. BY 42 IN. CRUSHER ON CAUVERY METUR DAM PROJECT.

separated into four grades, $\frac{5}{8}$ in., 1 in., $2\frac{1}{2}$ in., and oversize. The finer grades that are required are obtained in the disc crushers from the oversize material, these machines being capable of a reduction ratio in one operation of 4 or 5 to 1.

Some particulars of the power requirements of this crushing plant have also been supplied. The largest crushers each consume 175 h.p., the smaller ones require six motors of 120 h.p. each, one motor driving three crushers, and the disc crushers, together with each of their complimentary screens and elevators, are each driven by an 85 h.p. motor. All the plant is electrically operated. Fig. 2 shows another part of the installation, namely three of the secondary units.

DENVER PORTABLE MILLS

The Denver Equipment Co., of Denver, Colorado, publish an illustrated booklet describing their portable mill, which is illustrated in the accompanying photograph. This is a complete mill which can be assembled in approximately a week, ready for operation, and dismantled, if required to move, in a few days. The introduction of flotation made it possible to standardize on certain machines and equipment. With a few changes in the flow-sheet, certain equipment can be applied on four or five of the ores referred to, there being a series of flow-sheets suggested for the solution of five different problems. These mills are made

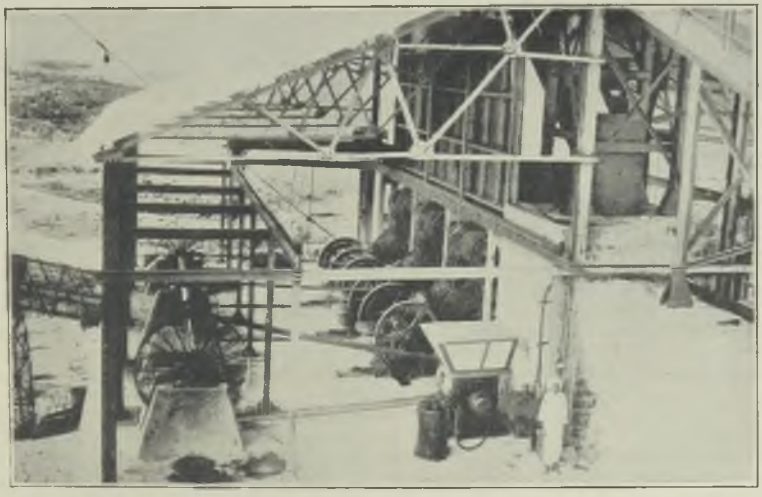
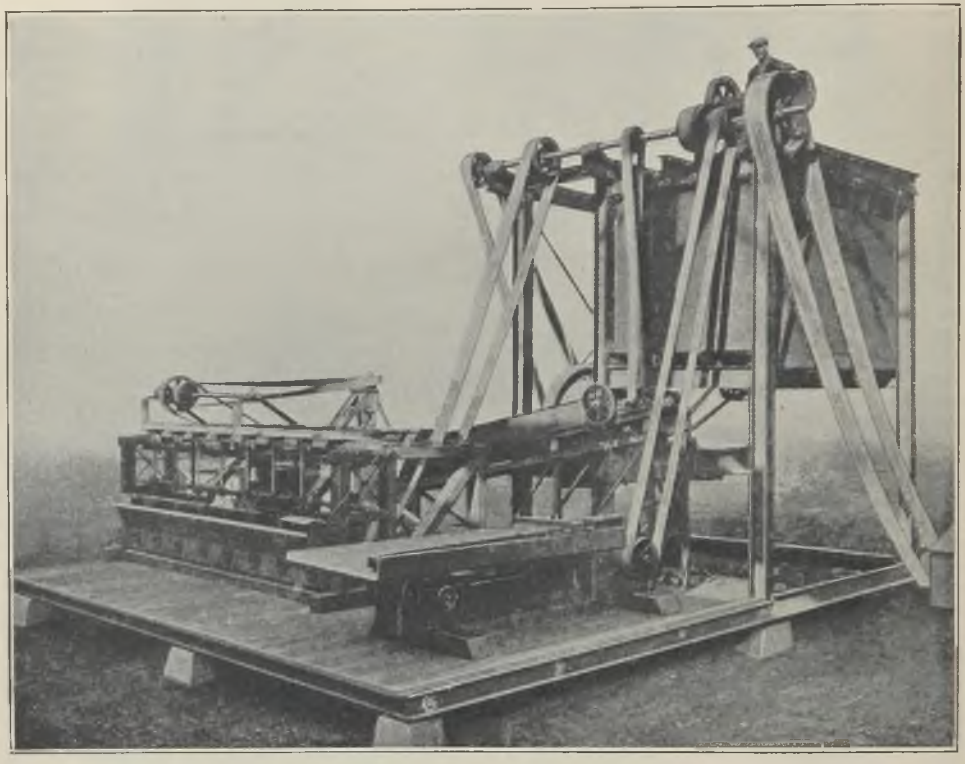


FIG. 2.—BATCH OF HADFIELD 24 IN. BY 13 IN. CRUSHERS ON CAUVERY METUR DAM PROJECT.

in three sizes, the 15 ton, 25 ton, and the 50 ton unit. After giving particulars of the component parts of each of these units for the five flow-sheets suggested, the booklet goes on to describe the individual parts in some detail.

The jaw crusher is of standard type and construction with a heavy flywheel and pulley. The jaw and cheek plates are of manganese steel, so as to resist wear. Adjustable jaws control the size of product. The vertical mill elevator is furnished complete with necessary elevator belting and buckets, and is totally enclosed in a housing. A take-up bearing is provided on the lower boot pulley so that proper tension is maintained on the belt at all times. The ore bin is made up of reinforced steel plates and is built into the steel framework. The bin has an opening at the bottom to discharge the ore on to the crushed ore feeder. The belt feeder consists of head and tail pulleys, with take-up bearing on tail pulley and necessary shafting, safety collars, bearings, idlers and endless conveyor belt, together with a friction speed control, so that the rate of feed to the ball or rod mill may be controlled or entirely shut off if desired. The ball mill or rod mill is a standard type, of heavy construction throughout. Spur gear and pinion drive together with a friction clutch pulley is furnished. The mill is lined throughout with special liners and has a combination scoop and drum feeder. The trommel discharge screen can be attached to the discharge trunnion of the ball mill. The screen covering can easily be changed to obtain various mesh products. The amalgamation plates are of cold rolled and annealed copper plates, having one ounce of silver covering per square foot. Plates are arranged to by-pass to one set while the other is being cleaned. The Denver classifier is of the latest improved type, embodying the reciprocating motion of the rake classifier with the rotating motion of the circular classifier. This dual motion turns the sands over and over, so that the slimes are freed and allowed to overflow. The classifier is complete with steel tank, rakes and dual running in oil head motion. The Denver conditioner is furnished to prepare the pulp properly for treatment in the flotation circuit. This is complete with mechanism, steel super-structure, shafting, bearings, driving pulleys and wood tank. Denver " Sub-A " (Fahrenwald) cells in the proper number to treat the tonnage of ore to be handled make up the flotation unit. Each cell has middling openings so that it is possible to rough, clean, or reclean in whatever arrangement and number of cells desired. The flotation cells are furnished for belted or motor drive, and are complete with all necessary woodwork, steelwork, ironwork, and drives. All of the latest improvements are embodied in this equipment, such as all " SKF " frictionless bearings on the impeller shaft assembly, wearing parts strengthened, and many other refinements. The centrifugal sand pump is of standard construction, mounted on a base with outboard bearing and pulley for belted drive. The Denver duplex oil feeder and dry reagent feeder are used to add the reagents to the pulp. The oil feeder is complete with oil cups, disc, tanks ; all of very rugged construction. The unit is mounted on one base and driven by means of a belted pulley. The dry reagent feeder is complete



THE DENVER PORTABLE MILL.

with pulleys, bearings, shafting, safety collars, idlers, and endless belt, all mounted on a stand with a belted speed reducer drive. The pilot concentrating table is a standard type, having a deck 42 in. by 84in. in size. This table is furnished complete with running in oil head motion and tight and loose pulleys, all mounted on suitable understructure.

Either a belt driven or a motor driven unit can be furnished. The complete transmission for the belt driven mill consists of necessary shafting bearings, pulleys, safety set collars, clutch pulley and all belting, with the exception of the main driving belt from the power unit. The line shafts are all mounted on the steel structural framework of the mill and thus independent of the surrounding mill building. The structural framework consists of steel members riveted and bolted together so that they support the mill equipment in their proper positions and no other foundation is required. The steel members are bolted into integral parts of the structure. These parts are all first assembled at our factory, each part marked and then knocked down for shipment in integral parts. They are bolted together in the field, with all steel markings corresponding to the construction blueprints furnished, thus forming the complete mill structure.

METAL MARKETS

COPPER.—After opening the month of March in a rather strong fashion, copper values subsequently drifted downwards and Standard quotations in London were marked down quite appreciably, whilst the export price of electrolytic copper in New York likewise fell from 10·50 cents to 10 cents per lb. f.a.s. Interest on the part of both European and American consumers remained restricted, whilst the situation continued to be overshadowed by the large surplus stocks. The prospects of a marked revival in values in the near future seem to be meagre, though of course much must depend on how world trade and industry develops during the current year. Although output has been cut down quite substantially, consumption does not yet appear to be making any serious inroads on world stocks.

Average price of Standard Cash Copper: March, 1931, £44 17s. 2d.; February, 1931, £45 8s. 3d.; March, 1930, £69 5s. 10d.; February, 1930, £71 10s. 3d.

TIN.—Despite the steadying influence of the Quota Scheme, prices eased slightly during March. There was a fair American demand on behalf of consuming industries over there, but European demand was sluggish. Unless general trade conditions improve it does not look as if the "bulls" will be able to rush prices up, after all, as had been feared. Sales in the East were fairly heavy during the month, but it is expected that these will fall away as the Quota Scheme begins to take full effect. The statistical position of the metal tended to improve somewhat during March, but it is still too soon to affirm that we are about to witness a steady diminution in the swollen world "visible supplies." Until this movement begins, however, it is difficult to see how the market can be regarded with anything approaching confidence.

Average price of Cash Standard Tin: March, 1931, £121 18s. 4d.; February, 1931, £118: March, 1930, £164 19s.; February, 1930, £173 16s. 6d.

LEAD.—This market also opened firm last month, mainly in sympathy with the stronger copper and tin markets, but easier conditions gradually supervened once more and prices lost ground. Lack of demand, plentiful market supplies, excessive world stocks—estimated at fully 300,000 tons—and inconclusive negotiations between the members of the Lead Producers Association contributed to undermine sentiment. Australian production is likely to be facilitated by the weak Australian exchange, and the imminent commencement of operations at the Mount Isa properties is not an encouraging factor from the market point of view. It does not look as if the lead market will display renewed strength until the world industrial situation mends decisively.

Average mean price of soft foreign lead: March, 1931, £13 4s. 9d.; February, 1931, £13 9s. 11d.; March, 1930, £18 17s. 5d.; February, 1930, £21 2s. 10d.

SPELTER.—The market enjoyed a temporary burst of strength at the beginning of March, but easier conditions soon set in again, and prices gradually sagged. Industrial demand remained restricted, there was considerable pressure of supplies and despite the efforts of some producers to curtail output, world stocks are now estimated at fully 250,000 tons. It looks as if the market will continue to present a somewhat heavy appearance until either production is cut down more seriously or a recovery occurs in world trade.

Average mean price of spelter: March, 1931, £12 8s. 7d.; February, 1931, £12 9s. 11d.; March, 1930, £18 11s. 1d.; February, 1930, £19 9s. 10d.

IRON AND STEEL.—The British pig-iron market remained dull during March, and there was considerable competition in Scotland with imported material offered at very cheap prices. Towards the close of the month, however, there was rather more confidence about, sales to domestic consumers having tended to improve, although exports still hung fire. Cleveland No. 3 foundry was maintained at 58s. 6d. per ton, minimum. The tendency of hematite was downwards during March, East Coast mixed numbers being sold at 67s. 6d. As regards British finished iron and steel, business began to improve towards the close of the month, some fair home and export orders having been booked. The almost complete absence of fresh contracts from the shipyards, however, was a serious factor from the point of view of the mills. The market for Continental steel tended to harden, owing to the withdrawal of certain Belgian and German mills from the market pending better prices.

IRON ORE.—Very quiet conditions have prevailed throughout the past month and only occasional cargoes have changed hands. Best Bilbao rubio remains nominally at 15s. 6d. per ton c.i.f.

ANTIMONY.—At the close of March English regulus was quoted at from £36 up to £42 10s. per ton. Chinese regulus on spot was in moderate request at £25 to £25 10s. ex warehouse. For metal for shipment from the East the value was about £23 per ton c.i.f.

ARSENIC.—The closing down of most of the Cornish tin mines has rendered supplies of Cornish arsenic very scarce and up to £21 per ton f.o.r. mines is now quoted. Mexican, however, remains at £17 10s. c.i.f. Liverpool.

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.	3 Months.			Cash.	3 Months.				Cash.	Forward.	
Mar.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	d.	s. d.
11	44 16 10½	45 8 1½	48 10 0	—	122 3 9	123 13 9	12 5 0	13 8 9	14 15 0	13 15/16	13 7/8	84 11½
12	45 3 9	45 16 3	48 10 0	—	122 3 9	123 13 9	12 3 9	13 5 0	14 15 0	13 11/16	13 3/4	84 11½
13	45 1 10½	45 11 10½	48 2 6	45 15 0	121 13 9	123 1 3	12 1 3	13 2 6	14 10 0	13 3/4	13 11/16	84 11½
16	44 16 10½	45 5 7½	48 2 6	—	121 8 9	122 18 9	12 2 6	13 1 3	14 10 0	14 1/16	14 7/16	84 11½
17	44 17 6	45 6 10½	48 2 6	45 15 0	123 1 3	124 11 3	12 3 9	13 1 3	14 10 0	14 1/4	14 3/16	84 10½
18	44 11 10½	45 1 10½	48 0 0	—	123 3 9	124 13 9	12 1 3	13 0 0	14 10 0	14 3/16	14 1/4	84 10
19	44 11 3	45 1 3	48 0 0	—	122 16 3	124 6 3	12 5 0	13 5 0	14 10 0	13 15/16	13 7/16	84 10½
20	44 19 4½	45 9 4½	48 0 0	46 0 0	123 2 6	124 11 3	12 6 3	13 0 0	14 10 0	13 11/16	13 3/4	84 10¾
23	44 13 1½	45 1 3	48 0 0	—	122 16 3	124 6 3	11 18 9	12 13 9	14 5 0	13 7/8	13 7/16	84 11
24	44 3 9	44 14 4½	47 10 0	45 5 0	121 6 3	122 16 3	11 10 0	11 13 9	13 5 0	13 11/16	13 11/16	84 10⅝
25	43 16 10½	44 10 7½	47 0 0	—	121 11 3	123 1 3	11 16 3	12 12 6	14 0 0	13½	13½	84 10½
26	43 10 7½	44 3 9	46 10 0	—	121 1 3	122 11 3	11 12 6	12 0 0	13 10 0	13½	13½	84 10½
27	43 1 10½	43 15 7½	46 5 0	44 5 0	120 8 9	122 0 0	11 7 6	12 2 6	13 10 0	13⅜	13 7/16	84 10¾
30	43 1 10½	43 15 7½	46 5 0	—	119 11 3	121 1 3	11 10 0	12 3 9	13 10 0	13 7/16	13½	84 10¾
31	43 0 0	43 13 1½	46 0 0	44 5 0	119 6 3	120 16 3	11 12 6	12 1 3	13 10 0	13 7/16	13½	84 9¾
Apr.												
1	43 8 1½	44 1 10½	46 0 0	—	119 16 3	121 6 3	11 15 0	12 2 6	13 10 0	12 15/16	13	84 10½
2	43 3 9	43 15 7½	46 0 0	44 5 0	119 6 3	120 13 9	12 0 0	12 15 0	14 0 0	12 15/16	12 15/16	84 10½
7	42 17 6	43 11 8½	46 0 0	44 5 0	117 6 3	118 13 9	11 16 3	12 8 9	13 15 0	12 15/16	12 15/16	84 10½
8	42 11 10½	43 5 7½	45 10 0	—	113 18 9	115 8 9	11 13 9	12 5 0	13 15 0	12 7/8	12 15/16	84 10⅜
9	43 8 1½	44 1 10½	46 0 0	—	116 6 3	117 16 3	11 17 6	12 3 9	13 10 0	12 15/16	12 15/16	84 10½
10	43 11 10½	44 4 4½	46 5 0	44 10 0	115 18 9	117 6 3	11 15 0	12 12 6	13 15 0	12 15/16	12 15/16	84 10½

BISMUTH.—The Bismuth Trust now has the situation well in hand, and with less outside competition prices have been advanced twice recently, the current quotation being 6s. per lb. for 5 cwt. lots and over.

CADMIUM.—A steady business continues on a moderate scale at 1s. 9½d. to 1s. 10½d. per lb.

COBALT METAL.—The official price remains at 10s. per lb.

COBALT OXIDES.—Officially prices are unchanged at 8s. per lb. for black and 8s. 10d. for grey, but business in black oxide is reported at much below the official price.

CHROMIUM METAL.—About 2s. 6d. to 2s. 7d. per lb. is quoted, business remaining fairly steady.

TANTALUM.—Hardly any demand is in evidence and prices are largely nominal at between £40 and £50 per lb.

PLATINUM.—The resumed negotiations between leading producers during March dragged on without any agreement being reached for the curtailment of production. During the negotiations the market became distinctly easier and refined metal is now quoted at about £5 to £5 10s. per oz.

PALLADIUM.—A steady business is reported at about £3 12s. 6d. to £4 per oz.

IRIDIUM.—Idle conditions rule in this market, sponge and powder being nominally held for £27 10s. to £30 per oz.

OSMIUM.—Although there is still a fairly good enquiry for this metal, prices are easier in sympathy with other metals of the group, current quotations being about £14 10s. to £15 per oz.

TELLURIUM.—Quotations are wholly nominal at 10s. to 12s. 6d. per lb.

SELENIUM.—A steady business continues to be done in 99% black powder at 7s. 8d. to 7s. 9d. per lb. ex warehouse Liverpool.

MANGANESE ORE.—France has shown a little interest during the past month, but otherwise there has not been much business moving. Some cheap freight space from India has resulted in very low-priced parcels being offered, good 48% ore having been offered at down to 10½d. per unit c.i.f. Washed Caucasian ore stands at about 10½d. to 11d. per unit c.i.f., with best Indian around 1s. to 1s. 0½d.

ALUMINIUM.—Only a very limited demand is apparent for aluminium just now, but quotations are held at the old level of £85 less 2%, delivered, for ingots and bars.

SULPHATE OF COPPER.—The demand for this material has not been brisk, but English makers have maintained prices at about £21 to £21 10s. per ton, less 5% f.o.r.

NICKEL.—Business has been quiet recently, but prices are unaltered at £170 to £175 per ton.

CHROME ORE.—Production in Rhodesia has had to be cut down owing to the smaller demand now in evidence, but prices are pretty well maintained at about 77s. 6d. to 80s. per ton c.i.f. for good 48% ore.

QUICKSILVER.—The past month has been singularly uneventful in the quicksilver market, demand being very slow but prices unchanged at £22 7s. 6d. per bottle, full terms, for spot material.

TUNGSTEN ORE.—Although there has been no appreciable expansion in demand recently and few transactions have been recorded, prices are distinctly firmer than they were a month ago. Partly owing to the better Chinese exchange position sellers adopted a firmer attitude and forward shipment from China is now held for about 13s. 6d. to 13s. 9d. per unit c.i.f.

MOLYBDENUM ORE.—Occasional parcels continue to be offered at about 31s. 6d. per unit c.i.f., but American concentrates in contract quantities are without change at 35s. 6d. per unit c.i.f.

GRAPHITE.—This is a rather quiet market just now, good 85 to 90% raw Madagascar flake being about £18 to £21 per ton c.i.f. and 90% Ceylon lumps about £20 to £22 c.i.f.

SILVER.—On March 2 spot bars closed at 12⅝d., but with an improving Chinese exchange values rose steadily to 14½d. on March 16. Subsequently, however, demand for silver tailed off again when it became apparent that no international conference on the question of rehabilitating the price was likely to be held yet awhile. By March 31 spot bars had relapsed to 13 3/16.

STATISTICS

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand.	Elsewhere.	Total.
	Oz.	Oz.	Oz.
March, 1930	852,089	37,281	889,370
April	831,996	36,610	868,606
May	876,893	39,320	916,213
June	847,352	40,515	887,867
July	871,468	41,184	912,652
August	878,474	42,607	921,081
September	860,311	42,865	903,176
October	884,632	41,929	926,561
November	844,038	40,715	884,753
December	867,202	41,290	908,492
January, 1931	873,872	40,704	914,576
February	800,991	38,946	839,937
March	869,331	41,667	910,998

TRANSVAAL GOLD OUTPUTS.

	February.		March.	
	Treated Tons.	Yield Oz.	Treated Tons.	Yield Oz.
Brakpan	92,800	£129,155	95,000	£144,978
City Deep	88,000	22,767	95,000	24,016
Cons. Main Reef	61,800	21,585	67,500	23,032
Crown Mines	237,000	75,035	266,000	84,037
D'rb'n Roodepoort Deep	43,200	14,381	46,800	14,992
East Rand P.M.	142,300	38,591	154,400	42,209
Geduld	79,000	25,386	85,500	27,131
Geldenhuis Deep	65,200	15,278	72,000	16,141
Glynn's Lydenburg	6,000	2,237	6,600	2,400
Government G.M. Areas	187,000	£370,644	203,000	£399,776
Kleinfontein	47,700	10,390	52,000	10,755
Langlaagte Estate	74,000	£109,521	80,000	£116,812
Luipaard's Vlei	29,500	7,465	33,000	8,022
Meyer and Charlton	16,700	£16,808	18,400	£17,686
Modderfontein New	150,000	64,368	166,000	70,281
Modderfontein B	67,000	20,053	73,500	21,785
Modderfontein Deep	42,000	21,272	44,200	22,500
Modderfontein East	65,500	19,656	72,000	21,452
New State Areas	73,000	£158,210	79,000	£170,698
Nourse	63,000	18,792	69,000	20,632
Randfontein	200,000	£235,856	225,000	£260,995
Robinson Deep	86,700	25,675	98,000	28,212
Rose Deep	58,000	12,373	63,500	12,821
Simmer and Jack	72,600	20,461	76,200	22,156
Springs	63,400	£133,082	66,400	£144,217
Sub Nigel	29,300	26,055	32,000	28,212
Transvaal G.M. Estates	14,200	4,330	15,700	4,898
Van Ryn	40,000	£39,053	43,000	£42,610
Van Ryn Deep	60,000	£92,201	63,000	£97,371
West Rand Consolidated	85,000	£100,947	94,000	£108,743
West Springs	63,000	£68,022	68,000	£72,244
Witw'tersr'nd (Knights)	51,500	£46,444	56,000	£48,332
Witwatersrand Deep	38,000	12,250	38,700	12,430

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.	£
Dec., 1929	2,528,000	28 3	19 11	8 4	1,058,231
January, 1930	2,618,600	28 2	19 9	8 5	1,103,718
February	2,421,100	28 5	20 0	8 5	1,019,482
March	2,663,820	28 1	19 8	8 5	1,121,216
April	2,549,250	28 7	20 1	8 6	1,084,504
May	2,741,634	28 1	19 8	8 5	1,153,549
June	2,651,970	28 2	19 7	8 7	1,141,197
July	2,706,900	28 5	19 8	8 9	1,184,107
August	2,693,100	28 3	19 6	8 9	1,174,828
September	2,653,250	28 5	19 8	8 9	1,160,430
October	2,741,080	28 5	19 7	8 10	1,212,822
November	2,628,800	28 4	19 7	8 9	1,145,097
December	2,661,200	28 6	19 9	8 9	1,160,548
January, 1931	2,721,316	28 3	19 8	8 7	1,171,456
February	—	—	—	—	1,045,980

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold Mines.	Coal Mines.	Diamond Mines.	Total.
March, 1930	200,134	15,350	7,002	222,316
April 30	202,434	15,109	5,565	223,108
May, 31	202,182	15,028	5,340	222,550
June 30	201,324	14,943	5,126	221,393
July 31	201,111	14,670	5,490	221,271
August 31	202,257	14,788	5,754	222,799
September 30	205,061	14,706	5,767	225,534
October 31	206,778	14,482	5,032	226,292
November 30	205,030	13,973	4,748	223,751
December 31	203,473	13,763	4,607	221,843
January 31, 1931	209,442	13,865	4,325	227,632
February 28	209,777	13,740	4,333	227,850
March 31	207,239	13,436	4,106	224,781

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	—
April	48,549	48,210	45,806	—
May	47,323	48,189	47,645	—
June	51,762	48,406	45,208	—
July	48,960	46,369	45,810	—
August	50,611	46,473	46,152	—
September	47,716	45,025	46,151	—
October	43,056	46,923	45,006	—
November	47,705	46,219	44,351	—
December	44,772	46,829	46,485	—

RHODESIAN GOLD OUTPUTS.

	February.		March.	
	Tons.	Oz.	Tons.	Oz.
Cam and Motor	22,400	9,962	24,800	10,286
Globe and Phœnix	5,842	5,100	6,016	5,129
Lonely Reef	5,900	3,115	6,500	3,225
Luiri Gold	1,281	£2,601	—	—
Rezende	6,000	2,427	6,400	2,679
Sherwood Star	4,200	£10,613	4,400	£10,281
Wanderer Consolidated	13,800	£14,556	15,000	3,078

WEST AFRICAN GOLD OUTPUTS.

	February.		March.	
	Tons.	Oz.	Tons.	Oz.
Ariston Gold Mines	3,909	£7,567	—	—
Ashanti Goldfields	11,000	13,319	12,018	14,146
Taquah and Abosso	9,830	£15,733	10,605	£16,747

AUSTRALIAN GOLD OUTPUTS BY STATES.

	Western Australia.	Victoria.	Queensland.
	Oz.	Oz.	Oz.
March, 1930	27,946	2,562	382
April	36,652	1,812	1,081
May	32,967	3,480	580
June	41,738	812	673
July	34,174	2,327	728
August	38,579	1,864	323
September	32,034	1,992	429
October	39,687	1,685	628
November	33,708	2,174	436
December	42,097	3,105	—
January, 1931	27,306	—	—
February	38,370	—	—
March	—	—	—

AUSTRALASIAN GOLD OUTPUTS.

	February.		March.	
	Tons	Value £	Tons.	Value £
Associated G.M. (W.A.)	4,824	6,499	4,889	7,861
Blackwater (N.Z.)	3,908	6,597	2,854	4,774
Boulder Persev'ce (W.A.)	6,412	13,880	6,673	15,347
Grt. Boulder Pro. (W.A.)	9,412	21,708	10,324	27,603
Lake View & Star (W.A.)	9,629	21,926	—	—
Sons of Gwalia (W.A.)	11,606	14,823	12,298	15,450
South Kalgurli (W.A.)	7,991	13,806	8,957	14,733
Waihi (N.Z.)	18,258	5,915* / 33,094†	—	— / —

* Oz. gold. † Oz. silver.

GOLD OUTPUTS, KOLAR DISTRICT, INDIA

	February.		March.	
	Tons Ore	Total Oz.	Tons Ore	Total Oz.
Balaghat	3,100	2,089	3,000	2,108
Champion Reef	7,560	5,181	8,500	5,609
Mysore	16,492	9,526	17,205	9,243
Nundydroog	11,800	7,029	12,184	7,254
Ooregum	11,026	4,246	9,600	4,525

MISCELLANEOUS GOLD, SILVER, AND PLATINUM OUTPUTS.

	February.		March.	
	Tons	Value £	Tons	Value £
Chosen Corp. (Korea)	8,080	12,730	9,580	15,430
Frontino & Bolivia (C'lbia)	2,340	13,472	2,510	11,663
Marmajito (Colombia)	950	4,560	1,100	4,559
Fresnillo	76,976	4,114*d*	—	—
Oriental Cons. (Korea)	15,281	77,000*d*	12,814	113,185*d*
St. John del Rey (Brazil)	—	41,000	—	44,000
Santa Gertrudis (Mexico)	35,108	54,627*d*	—	—
West Mexican Mines	1,260	35,000*d*	1,190	24,000*d*

d Dollars.

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

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

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

OUTPUTS OF MALAYAN TIN COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Ayer Hitam	131	142⅔	107½
Batu Caves	22	16½	24
Changkat	53	67	40
Gopeng	71½	73	59½
Hongkong Tin	53½	56	50½
Idris Hydraulic	28	32⅔	20⅔
Ipoh	55½	33½	37½
Kampar Malaya	87	49	67
Kampong Lanjut	55	52	82
Kamunting	—	—	152½
Kent (F.M.S.)	29	21	28
Kinta	30	30	22½
Kinta Kellas	59⅛	81½	68⅔
Kramat Tin	75	76	75
Kuala Kampar	65	95	42
Kundang	35	—	8
Lahat	20½	19½	20¼
Larut Tin Fields	—	—	—
Malaya Consolidated	55	48½	63
Malayan Tin	148⅔	144½	131
Malim Nawar	30	28	18
Pahang	256	255⅔	255½
Penawat	73½	53½	69½
Pengkalen	77½	63	65½
Petaling	184½	195	176
Rahman	53½	59⅓	65½
Rambutan	9½	11	9½
Rantau	30	21	22
Rawang	65	56	65
Rawang Concessions	35	50	40
Renong	63½	47½	63½
Southern Malayan	199½	170½	163⅔
Southern Perak	37½	50½	35½
Southern Tronoh	45	40	45
Sungei Besi	42	47	42
Sungei Kinta	24	23¼	38⅔
Sungei Way	119	107½	119
Taiping	18	14½	23
Tanjong	45	51	44½
Teja Malaya	29⅔	22½	26⅔
Tekka	50½	63½	33
Tekka-Taiping	60	56	57½
Temengor	—	10⅔	—
Temoh	57	46⅔	41
Tronoh	90	83	93
Ulu Klang	—	—	26½

OUTPUTS OF NIGERIAN TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Amari	4½	—	—
Anglo-Nigerian	61	64	58
Associated Tin Mines	250	205	220
Baba River	7	7	7
Batura Monguna	4½	3⅔	5
Bisichi	50	44	49
Daffo	10⅔	7	—
Filani	4½	3	2½
Jantar	22	22	21
Jos	24	20	—
Juga Valley	8	6½	5
Kaduna Syndicate	19	22	—
Kaduna Prospectors	11	9	—
Kassa	11	9	12½
London Tin	80	140	220
Lower Bisichi	8	6⅔	—
Naraguta	17½	22	—
Naraguta Durumi	—	6	—
Naraguta Extended	10	12	10
Naraguta Karama	20	19½	—
Naraguta Korot	8⅔	7	—
Nigerian Consolidated	14	14	14
Offin River	6	5½	3⅔
Ribon Valley	11	9	8
South Bukeru Areas	12	10	11
Tin Fields	6⅔	4½	4½
Tin Properties	—	—	—
United Tin Areas	23	18	18
Yarde Kerri	11	11	—

OUTPUTS OF OTHER TIN MINING COMPANIES.

In Long Tons of Concentrate.

	Jan.	Feb.	Mar.
Anglo-Burma (Burma)	20⅔	14	15½
Aramayo Mines (Bolivia)	285	269	198
Bangrin (Siam)	79	69½	82½
Consolidated Tin Mines (Burma)	120	120	90
East Pool (Cornwall)	41½	41	43⅔
Fabulosa (Bolivia)	120	90	—
Geevor (Cornwall)	41½	—	—
Kagera (Uganda)	28	16	20
Kamra	—	38	—
Malaysiam Tin	23⅔	24½	28½
Mawchi	—	265*	—
Patino	1,413	—	—
Pattani	—	35½	—
Rooiberg Minerals	—	28	27
San Finx (Spain)	30*	—	—
Siamese Tin (Siam)	148¾	175½	188⅔
Tavoy Tin (Burma)	60	49⅔	61
Tongkah Harbour (Siam)	29	32	70
Toyo (Japan)	80½	72½	64½
Zaaiplaats	20⅔	20½	—

* Tin and Wolfram.

COPPER, LEAD, AND ZINC OUTPUTS.

		Feb.	Mar.
Broken Hill South	Tons lead conc.	5,296	5,001
	Tons zinc conc.	—	—
Burma Corporation	Tons refined lead	6,420	6,700
	Oz. refined silver	530,000	530,000
Electrolytic Zinc	Tons zinc	4,133	—
Indian Copper	Tons copper	350	350
Messina	Tons copper	669	753
Mount Lyell	Tons concentrates	3,097	3,161
North Broken Hill	Tons lead conc.	5,110	5,280
	Tons zinc conc.	—	—
Poderosa	Tons copper ore	392	392
Rhodesia Broken Hill	Tons V_2O_5	15½	23
	Tons slab zinc	1,233	1,335
San Francisco Mexico	Tons lead conc.	3,315	3,823
	Tons zinc conc.	3,458	4,097
Tetiuhe	Tons lead conc.	925	—
	Tons zinc conc.	1,976	—
Trepca	Tons lead conc.	3,496	3,549
	Tons zinc conc.	2,404	2,421
Zinc Corporation	Tons lead conc.	5,915	—
	Tons zinc conc.	4,363	—

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

		January.	February.
Iron Ore	Tons	206,755	180,035
Manganese Ore	Tons	9,152	11,670
Iron and Steel	Tons	221,773	177,056
Copper and Iron Pyrites	Tons	31,474	15,281
Copper Ore, Matte, and Prec.	Tons	1,530	3,063
Copper Metal	Tons	13,706	12,564
Tin Concentrate	Tons	6,276	5,158
Tin Metal	Tons	590	1,080
Lead Pig and Sheet	Tons	22,591	20,147
Zinc (Spelter)	Tons	10,111	9,780
Zinc Sheets, etc.	Tons	2,656	2,002
Aluminium	Tons	404	1,287
Mercury	Lb.	18,450	106,217
Zinc Oxide	Tons	670	485
White Lead	Cwt.	10,932	12,919
Red and Orange Lead	Cwt.	2,112	2,502
Barytes, ground	Cwt.	35,946	38,897
Asbestos	Tons	2,330	2,222
Boron Minerals	Tons	601	1,004
Borax	Cwt.	20,626	12,319
Basic Slag	Tons	3,773	3,081
Superphosphates	Tons	10,903	16,156
Phosphate of Lime	Tons	20,058	25,065
Mica	Tons	240	179
Sulphur	Tons	4,082	3,154
Nitrate of Soda	Cwt.	118,192	93,294
Potash Salts	Cwt.	198,225	220,947
Petroleum : Crude	Gallons	32,112,797	42,624,621
Lamp Oil	Gallons	32,303,540	26,863,079
Motor Spirit	Gallons	78,617,991	57,514,983
Lubricating Oil	Gallons	7,399,204	4,295,166
Gas Oil	Gallons	5,704,855	4,066,517
Fuel Oil	Gallons	48,002,195	32,422,896
Asphalt and Bitumen	Tons	15,137	14,580
Paraffin Wax	Cwt.	122,010	88,821
Turpentine	Cwt.	44,254	27,927

OUTPUTS REPORTED BY OIL-PRODUCING COMPANIES.

In Tons.

	January.	February.	March.
Anglo-Ecuadorian	17,040	14,890	15,541
Apex Trinidad	40,060	36,900	45,930
Attock	1,081	1,492	—
British Burmah	4,614	4,105	4,559
British Controlled	36,073	31,721	—
Kern Mex	785	725	815
Kern River (Cal.)	1,482	1,496	1,790
Kern Romana	1,822	1,431	1,140
Kern Trinidad	5,457	5,322	5,626
Lobitos	26,605	23,662	25,418
Phœnix	62,149	52,219	61,249
St. Helen's Petroleum	6,003	5,228	5,921
Steaua Romana	88,950	80,790	85,710
Tampico	3,187	2,789	—
Tocuyo	2,382	2,518	2,348
Trinidad Leaseholds	23,550	20,000	20,050

QUOTATIONS OF OIL COMPANIES' SHARES.

Denomination of Shares £1 unless otherwise noted.

	Mar. 10, 1931.			April 10, 1931.		
	£	s.	d.	£	s.	d.
Anglo-Ecuadorian		9	0		8	9
Anglo-Egyptian B.	2	4	3	2	1	9
Anglo-Persian 1st Pref.	1	5	9	1	5	6
,, ,, Ord.	2	3	9	2	1	9
Apex Trinidad (5s.)		10	3		10	0
Attock		16	3		15	6
British Burmah (8s.)		4	0		4	0
British Controlled ($5)		1	3		2	0
Burmah Oil	3	3	9	3	2	6
Kern River Cal. (10s.)		2	6		2	3
Lobitos, Peru	1	5	0	1	1	9
Mexican Eagle, Ord. (4 pesos)		9	0		8	9
,, ,, 8% Pref. (4 pesos)		9	6		9	3
Phœnix, Roumanian		6	6		6	0
Royal Dutch (100 fl.)	23	12	6	23	0	0
Shell Transport, Ord.	3	5	6	3	3	0
,, ,, 5% Pref. (£10)	10	2	6	10	0	0
Steaua Romana		4	3		3	6
Trinidad Leaseholds	1	2	0	1	1	3
United British of Trinidad (6s. 8d.)		5	6		5	0
V.O.C. Holding	1	13	9	1	11	3

PRICES OF CHEMICALS. Apr. 10.

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

		£	s.	d.
Acetic Acid, 40%	per cwt.		18	9
,, 80%	,,	1	16	3
,, Glacial	per ton	58	0	0
Alum	,,	8	7	6
Aluminium Sulphate, 17 to 18%	,,	6	15	0
Ammonium, Anhydrous	per lb.			11
,, 0·880 solution	per ton	15	10	0
,, Carbonate	,,	27	10	0
,, Nitrate (British)	,,	16	0	0
,, Phosphate, comml.	,,	40	0	0
,, Sulphate, 20·6% N.	,,	9	10	0
Antimony, Tartar Emetic, 43/44%	per lb.			11
,, Sulphide, crimson	,,		1	4
Arsenic, White	per ton	19	7	6
Barium, Carbonate, 94%	,,	4	10	0
,, Chloride	,,	8	15	0
,, Sulphate, 94%	,,	6	15	0
Benzol, standard motor	per gal.		1	3
Bleaching Powder, 35% Cl.	per ton	7	0	0
Borax	,,	13	10	0
Boric Acid	,,	22	0	0
Calcium Chloride, solid, 70/75%	,,	5	5	0
Carbolic Acid, crude 60's	per gal.		1	2
,, ,, crystallized, 40°	per lb.			5½
Carbon Disulphide	per ton	16	10	0
Citric Acid	per lb.		1	0½
Copper Sulphate	per ton	20	0	0
Creosote Oil (f.o.b. in Bulk)	per gal.			4½
Cresylic Acid, 98-100%	,,		1	8
Hydrofluoric Acid, 59/60%	per lb.			6
Iodine	per oz.		1	0
Iron, Nitrate 80° Tw.	per ton	6	10	0
,, Sulphate	,,	2	2	6
Lead, Acetate, white	,,	33	0	0
,, Nitrate (ton lots)	,,	29	10	0
,, Oxide, Litharge	,,	29	10	0
,, White	,,	38	0	0
Lime, Acetate, brown	,,	7	5	0
,, ,, grey, 80%	,,	13	0	0
Magnesite, Calcined	,,	9	10	0
Magnesium, Chloride	,,	5	10	0
,, Sulphate, comml.	,,	3	15	0
Methylated Spirit 64° Industrial	per gal.		1	9
Nitric Acid, 80° Tw.	per ton	23	0	0
Oxalic Acid	per cwt.	1	12	0
Phosphoric Acid. S.G. 1·500	per ton	29	15	0
Pine Oil	,,	42	10	0
Potassium Bichromate	per lb.			4½
,, Carbonate, 96/98%	per ton	25	0	0
,, Chlorate	,,	27	10	0
,, Chloride 80%	,,	9	5	0
,, Ethyl Xanthate	per 1,016 kilos	55	15	0
,, Hydrate (Caustic) 88/90%	per ton	28	10	0
,, Nitrate	,,	19	17	6
,, Permanganate	per lb.			5¾
,, Prussiate, Yellow	,,			6¾
,, ,, Red	,,		1	8
,, Sulphate, 90%	per ton	10	10	0
Sodium Acetate	,,	17	0	0
,, Arsenate, 45%	,,	20	10	0
,, Bicarbonate	,,	10	10	0
,, Bichromate	per lb.			3½
,, Carbonate (Soda Ash) 58%	per ton	6	0	0
,, ,, (Crystals)	,,	5	5	0
,, Chlorate	,,	26	5	0
,, Cyanide 100% NaCN basis	per lb			7
,, Ethyl Xanthate	per 1,016 kilos	53	5	0
,, Hydrate, 76%	per ton	14	10	0
,, Hyposulphite, comml.	,,	9	2	6
,, Nitrate (ordinary)	,,	10	0	0
,, Phosphate, comml.	,,	10	0	0
,, Prussiate	per lb.			4¾
,, Silicate	per ton	9	10	0
,, ,, (liquid, 140° Tw.)	,,	8	10	0
,, Sulphate (Glauber's Salt)	,,	3	0	0
,, ,, (Salt-Cake)	,,	2	15	0
,, Sulphide Conc., 60/65%	,,	8	15	0
,, Sulphite, pure	per cwt.		14	0
Sulphur, Flowers	per ton	10	10	0
,, Roll	,,	10	10	0
Sulphuric Acid, 168° Tw.	,,	4	12	0
,, free from Arsenic, 144° Tw.	,,	3	15	0
Superphosphate of Lime (S.P.A. 16%)	,,	3	9	0
Tartaric Acid	per lb.			11½
Turpentine	per ton	43	10	0
Tin Crystals	per lb.			11¾
Titanous Chloride	,,			10
Zinc Chloride	per ton	9	10	0
Zinc Dust, 90/92%	,,	20	0	0
Zinc Oxide (White Seal)	,,	35	0	0
Zinc Sulphate	,,	8	5	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD AND SILVER:	Mar. 10, 1931.	April 10, 1931.
SOUTH AFRICA:	£. s. d.	£ s. d.
Brakpan	2 18 9	3 0 0
City Deep	5 0	4 9
Consolidated Main Reef	1 3 3	1 4 0
Crown Mines (10s.)	4 3 9	4 6 6
Daggafontein	2 0 0	2 3 9
Durban Roodepoort Deep (10s.)	14 9	16 6
East Geduld	2 12 6	2 15 6
East Rand Proprietary (10s.)	10 3	12 6
Geduld	3 18 0	4 0 9
Geldhenhuis Deep	8 0	8 0
Glynn's Lydenburg	3 9	3 9
Government Gold Mining Areas (5s.)	1 12 0	1 11 9
Langlaagte Estate	1 5 3	1 6 0
Meyer & Charlton	16 3	15 0
Modderfontein New (10s.)	3 6 3	3 8 0
Modderfontein B (5s.)	9 6	10 6
Modderfontein Deep (5s.)	1 2 6	1 1 9
Modderfontein East	1 8 0	1 14 3
New State Areas	2 3 0	2 3 9
Nourse	12 9	14 3
Randfontein	1 0 0	1 3 3
Robinson Deep A (1s.)	15 0	15 0
,, ,, B (7s. 6d.)	10 9	12 0
Rose Deep	6 3	6 6
Simmer & Jack (2s. 6d.)	3 0	3 6
Springs	3 4 0	3 3 0
Sub Nigel (10s.)	3 1 0	3 3 9
Van Ryn	7 6	8 3
Van Ryn Deep	1 6 3	1 7 6
Village Deep (14s.)	6 3	6 3
West Rand Consolidated (10s.)	10 0	12 0
West Springs	12 6	13 6
Witwatersrand (Knight's)	10 6	10 6
Witwatersrand Deep	4 3	5 0
RHODESIA:		
Cam and Motor	1 0 0	18 9
Gaika	3 6	3 6
Globe and Phœnix (5s.)	14 0	15 9
Lonely Reef	15 0	16 3
Mayfair	7 6	3 9
Rezende	1 0 0	1 2 6
Shamva	1 0	1 0
Sherwood Starr (5s.)	13 9	13 9
GOLD COAST:		
Ashanti (4s.)	1 8 0	1 8 9
Taquah and Abosso (5s.)	4 6	4 6
AUSTRALASIA:		
Golden Horseshoe (4s.) W.A.	2 0	2 3
Great Boulder Propriet'y (2s.), W.A.	1 3	1 3
Lake View and Star (4s.), W.A.	10 6	10 3
Sons of Gwalia, W.A.	4 0	4 3
South Kalgurli (10s.), W.A.	11 6	11 6
Waihi (5s.), N.Z.	14 0	13 6
Wiluna Gold, W.A.	18 6	17 9
INDIA:		
Balaghat (10s.)	2 0	2 0
Champion Reef (10s.)	8 0	7 3
Mysore (10s.)	10 6	9 6
Nundydroog (10s.)	17 0	15 6
Ooregum (10s.)	3 0	3 6
AMERICA:		
Camp Bird (2s.), Colorado	6	6
Exploration (10s.)	3 0	3 0
Frontino and Bolivia, Colombia	8 9	8 9
Mexican Corporation, Mexico (10s.)	4 9	4 6
Mexico Mines of El Oro, Mexico	2 0	2 0
Panama Corporation	17 6	17 3
St. John del Rey, Brazil	1 0 6	1 1 0
Santa Gertrudis, Mexico	7 9	7 6
Selukwe (2s. 6d.), British Columbia	3 0	2 6
MISCELLANEOUS:		
Chosen, Korea	4 3	5 0
Lena Goldfields, Russia	6	6
COPPER:		
Bwana M'Kubwa (5s.) Rhodesia	6 3	6 0
Esperanza Copper	13 9	13 9
Indian (2s.)	1 6	1 3
Loangwa (5s.), Rhodesia	2 0	1 9
Lniri (5s.), Rhodesia	3 0	2 9
Messina (5s.), Transvaal	11 6	10 0
Mount Lyell, Tasmania	17 6	16 9
Namaqua (£2), Cape Province	5 0	5 0
N'Changa, Rhodesia	1 15 0	1 15 0
Rhodesia-Katanga	17 6	18 9
Rio Tinto (£5), Spain	28 5 0	26 2 6
Roan Antelope (5s.), Rhodesia	17 0	17 6
Tanganyika Con.	1 12 0	1 5 6
Tharsis (£2), Spain	3 15 0	3 3 9

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

BROKEN HILL MINERALS

The substance of a paper by G. Smith, read before the Royal Society of New South Wales in November last, appears in the *Chemical Engineering and Mining Review* of Melbourne for February 5. The paper deals with some of the more uncommon minerals occurring in the Broken Hill lode. The author points out that the outcrop of the Broken Hill lode has been variously described as a manganic ironstone, manganiferous iron ore, and ironstone. None of these designations appears to be applicable. It contained a large percentage of pyromorphite with patches of siliceous, ferruginous, and aluminous material, and was not uniform in size, composition or contour, but even with these mixtures it maintained a manganiferous character throughout.

When smelting was in progress at the British mine the outcrop was used for fluxing purposes; its lead content was then found to be as high as 25% and its manganese content exceeded that of the iron. Pyromorphite was not confined to the outcrop of the British mine, but the writer is unable to state in what quantity it existed elsewhere along the lode, but it was plainly visible at that date. At the present time the continuation of this outcrop is being mined at the Zinc Corporation mine, where, though small, it is said to be composed practically of pure psilomelane. In its original unbroken condition it formed a black mass of imposing dimensions, the only black outcrop on the field. Omitting its lead content, its silica and alumina, it might be appropriately described as ferruginous psilomelane.

The writer, during investigations extending over many years, has been unable to verify the presence of cerargyrite in the ores of the Broken Hill lode, though other silver haloids, embolite and iodyrite, have been found to be present in such abundance. At the Australian Museum, Sydney, a large number of chloro-bromide type minerals from the lode have been tested, but none has been found which does not conform to the embolite or iodembolite series. It is worthy of note that cerargyrite, which occurred so plentifully in the Consols lode, should be absent from the adjacent Broken Hill lode, while embolite, the commonest haloid present in the latter, was not found in the former, a fact in keeping with the great dissimilarity between the silver minerals of the respective lodes.

The existence of iodobromide has also not been confirmed, though the writer at an early period determined, among the minerals from the Broken Hill lode, the chloro-bromo-iodide which apparently remained otherwise unknown until 10 years later, when it was more closely investigated by Messrs. Prior and Spencer, who gave it the specific name of iodembolite. It is still scarcely known as a mineral distinct from embolite, though it was not uncommon in the shallower levels of the lode.

The only complete analysis of silver chloride available is that of a slug or "shode stone" from Silverton. This analysis is unusually interesting by reason of the fact that it shows the presence of iron carbonate together with lime-magnesia carbonates, of which it is suggested that none was lode material, the first because it could not have resisted oxidation and the latter because they were known as incrustations by surface waters and unknown as a part of limonite lodes which had been derived from the oxidation of siderite. The absence of ferric oxide, assuming the analysis to be correctly recorded, is alone sufficient to separate this particular slug from others of similar origin, and to place it in a class by itself. If oxide be substituted for carbonate of iron in the analysis, a slug of more normal type would be indicated.

Cerargyrite was generally observed to be compact, embolite being commonly coralloidal. Some of the "shode stones" enclosed within a crust of limonite were in coralloidal form, resembling the commonest type of embolite of the Broken Hill lode, but they were not determined mineralogically. This fragile mineral could not have survived surface attrition without some protecting material, and nothing of this nature was seen in association with it, or with any of the slugs, except limonite, siliceous or otherwise, in which they had originally been enclosed when in situ. The slugs were found only in the vicinity of limonite lodes from which they had been shed, particularly in the Apollyon Valley-Purnamoota district. Many passed through the writer's hands, all of which were encased, wholly or partly, in this gangue; none was free from it, and carbonate of iron was seen in none.

As a lode gangue carbonate of iron is as much an under-water mineral as cerargyrite is a secondary ore which may skirt along the water level without passing below it. The former shows signs of oxidation just above the water level and this increases as the surface is approached, the unaltered core becoming ever smaller and the characteristic cleavage less distinct. The waste heaps on mines which produced this mineral afford evidence of its oxidation when exposed to the atmosphere. The writer has pieces of siderite from the Consols and Pioneer (Thackeringa) lodes which have been exposed on the surface of those mines for possibly 30 years or more. The effect of oxidation is shown upon each by its colour, which has been superficially changed from the characteristic fawn of siderite to the dark brown of limonite. It may be gathered from these examples that surface exposure in a dry climate would require a long period to complete the change to the centre, and even then it would be partial only, as the darkened portion is but an early and incomplete stage in the progress of oxidation. The gradation

from pure siderate to pure limonite in all its stages has been carefully noted underground from the surface to water level, and it would seem that moist conditions in the lode accelerated the process. The period of time occupied in completing in situ the change from one extreme to the other under conditions that now exist would seem to have been a lengthy one, as speculative as that connected with the wearing down of the surface level which resulted in the shedding of the slugs.

Iodyrite has been recorded as having occurred in cerussite in the Broken Hill lode. The writer has seen no such association. For some reason for which no explanation is suggested, it was known to impregnate the dry ores only, and in them it occurred in large quantity. It is an interesting fact that the iodide was the only silver haloid known to be common to the very dissimilar Broken Hill, Consols and East Consols lodes which were adjacent to, and yet, so far as known, quite distinct from each other. In its mode of occurrence it differed in each mine, but in no instance was it seen in association with lead minerals. It was not known to occur in any other lode on the Barrier field.

About 1,895 slabs of compact limonite were obtained from the Broken Hill Pty. mine, upon which had been deposited the largest and finest crystals of iodyrite seen on the field. These crystals formed irregular lines upon the surface of the limonite and it was noted that they followed cracks in the gangue, which otherwise was free from this or any other material. There was no deviation from the direction taken by the cracks and it seemed reasonable to suppose that the mineralizing influence necessary for the precipitation of the silver had passed upwards through the openings, and so caused deposition from silver-bearing solutions at the point of contact. This occurrence was of high scientific and spectacular value ; the crystals were pure, perfect and free from the incrustation which covers the best of the prisms of this mineral which were found upon the same gangue in the same mine. These specimens were not exhibited, but were taken from Australia shortly after their discovery. There was but one such occurrence known.

An interesting example of secondary galena which in its mode of deposition resembles the iodide crystals specially referred to, is on view at the Mining Museum, Sydney. It may indeed have been formed under analogous conditions.

The massive type of pyromorphite has already been referred to as a component part of the Broken Hill lode outcrop ; in its occurrence with the psilomelane there was an intimate connexion not only in their general association but in the fact that manganese oxide had penetrated into its small interstices. The under-surface pyromorphite was always crystallized and was the most variable mineral found in the lode (nine distinct types have been recorded). Its physical characters varied with depth, a relative term measured by conditions rather than by distance. At the time of its deposition it would be in accord with the conditions prevailing at those points ; hence it may be assumed that each variety indicated some variation of those conditions where and when it was deposited. The canary-coloured crystals of the upper portion of the oxidized zone would have seemed out of place in any other matrix than that composed of the friable, semi-decomposed, siliceous cerusite which enclosed them, while the solid mammillated and botryoidal forms of the sulphide association appeared to be appropriately placed in the position in which they were found. Having regard to this great dissimilarity between the highest and lowest varieties, it would appear most improbable that they would have been deposited in the same forms if their relative positions in the lode had been reversed.

It is, however, not intended to convey that all the pyromorphite associated with the sulphide ores was of the solid type. A large quantity of small, delicate crystals was found overlying leached sulphides in the Junction mine in 1889, probably the first of this association met with. Depths at which these different varieties occurred were unequal and the surrounding conditions probably differed accordingly. Whatever the cause of such great variations in form may have been, the sulphide connexion was strongly shown upon them ; none possessed the characteristics by which those of the upper zone could be identified.

It is probable that the various types differed in composition as in physical characters, though little is known of their chemistry. Tests were made 35–40 years ago, but the results cannot be recalled after such a lapse of time. In quantity, owing to the large occurrences in the outcrop, this mineral ranked as the third, and last, of the great lead-producing minerals of the Broken Hill lode.

The statement that zinc has been obtained in New South Wales from calamine and zincite was perhaps due to inadvertence. It is true that calamine was mined in the oxidized zone of the Broken Hill lode, but it was as part of the gangue ; it was not treated with the object of obtaining that metal. Zincite is a rare mineral which is not known to occur in New South Wales or indeed in Australia.

The occurrence of calamine has been as follows :— "On the ceilings of the numerous vughs, which occur all through the oxidized ores, stalactites, either of psilomelane and limonite, or a combination of these two minerals, occur coated with zinc carbonate, while more rarely large stalactites possessing a columnar structure entirely composed of calamite are seen. The amount of zinc distributed through the mass of the oxidized ores is, however, very small, and yet we know it has been derived from highly zinciferous sulphides. A consideration of these circumstances has led to the suggestion that the zinc carbonate, being more soluble than the other ore constituents, has been leached out from them and reprecipitated in the sulphide ore below, and in this way the intimate association of zinc and lead sulphides has been brought about."

The occurrences so described were unusually interesting ; they differed in the order of introduction and appeared to indicate an unequal adaptability in their mode of deposition. Each mineral had been deposited separately, probably denoting a different phase in regard to time, though it seemed probable that there had been some simultaneous deposition. In their sequence there was no observable variation, limonite being the first to form stalactites (and stalagmites), followed apparently closely by psilomelane, which covered many of the stalactites while they were yet very small. The comparatively few limonite stalactites

which remain free from the covering of psilomelane were very much larger, and it is believed their enlargement was simultaneous with the deposition of psilomelane upon the small ones. Compared with limonite, the quantity of material contained in the psilomelane stalactites was very much greater. In no instance was any deposition of limonite upon psilomelane known to occur.

The deposition of psilomelane had apparently been completed before the calamine appeared, as the crystals showed no stains to indicate later deposition of either of the oxides; there was no overlapping or repetition of any of the minerals.

It was in these particular vughs that the finest crystals of calamine were found; they were more closely connected with the psilomelane, probably because the crystals readily adhered to its hard surfaces rather than to the soft material of the limonite.

It would appear that after these three minerals had been deposited embolite was introduced and precipitated impartially upon both psilomelane and calamine. In this connexion the only instance of mixing was noticed, particles of embolite being enclosed in some crystals of calamine; the entry of the embolite thus appears to have occurred just before the completion of the calamine crystallization. Stalactites of psilomelane without the minute nucleus of limonite were noted, but they were far less common.

The large columnar stalactites, in whatever part of the lode they occurred, had also started their growth upon psilomelane, which invariably enclosed the same small limonite stalactite, as could be seen when the stalactites were broken off at their base. These larger deposits of calamine contained no definite crystals, and, though occurring in the form of stalactites (and stalagmites), were not stalactitic in character as the term is generally understood. In the Broken Hill lode it occurred only as definite crystals or crystalline groups; the amorphous type which might have formed true stalactites was unknown. In stalactitic form calamine was present only as an aggregation of crystalline grains upon pre-existing stalactites of psilomelane. These grains formed a very rough, uneven, granular surface, very unlike the smooth sides down which solutions pass to dripping points, as may be seen in progress in the formation of limestone, limonite and other stalactites. There were no dripping points of calamine; the psilomelane had served as a necessary base to build upon, not to drain from, and once established the deposition of the calamine upon itself obviously continued until the stalactites increased enormously in size, and, in some instances, reached the growing stalagmite and so formed large columns.

Consideration of the above would suggest that crystalline structure and stalactitic growth are incompatible; this has also been so noted in other lodes. To describe these occurrences as stalactites is not strictly correct; they were so in form, but not in reality; the calamine was simply an investing mineral upon true stalactites composed of other minerals, and therefore stalactites entirely composed of calamine were not seen as stated.

The presence of cobalt bloom (erythrite) and smaltite has been recorded as having occurred in the Consols lode. Both were met with in small quantity. By far the most important cobalt mineral present was cobaltite, which was found plentifully in this lode at various periods from 1890 to 1898. Some of the deposits were of considerable economic value owing to their high silver content.

THE HOLE-DIRECTOR IN RAND MINING

In March, 1927, an account of the use of the hole-director in the placing of blasting holes was given in the MAGAZINE in an article on underground practice by B. Beringer. This information was amplified in December of the following year by an abstract from articles appearing in the *South African Mining and Engineering Journal*. Last month, however, a particularly detailed account of the use of hole-directors in ground-breaking control was given by H. Simon in the *Bulletin* of the Institution of Mining and Metallurgy and extracts from his paper are given here. The author has carried out much detailed work in the Crown Mines on the Witwatersrand and the results obtained by the use of these devices are presented in his paper.

The author says that investigation into the methods of rock-breaking in use revealed a need for better control and a more scientific method of regulating the burden upon each hole to be drilled. "Rock-breaking" comes into question first in "development" and secondly in "stoping." Both can be subjected to complete control. In order to obtain this close control it becomes necessary to isolate the variables. These consist of the burden on the hole, the charge placed in the hole, and the rock characteristics.

For any one development end and for a short period of time the rock characteristics may be taken as constant. The burden or the charge placed in the hole may then be varied, until the combination is discovered which is likely to give the highest breaking efficiency. The cost of the explosive is very little over one-third the cost of drilling the hole to take the charge, thus a mechanical aid to directing the hole and fixing the burden becomes of first importance.

If it is admitted that each hole should have a definite burden varied to suit local conditions, then this burden can be directed better instrumentally than merely by eye. Without a mechanical aid a burden is often not even approximately correct. It is almost impossible to judge by eye the direction for a series of holes to give an exact burden to each, or, for example, to meet at 10 ft. from the plane in which they commenced. The most skilful miner without a "director" cannot compete with the novice instrumentally aided in burdening a series of holes.

In each case it is necessary that the "director" be of as simple a design as possible, of robust structure, although of light weight. This last applies particularly to stoping, where, if the director is too heavy or cumbersome, the miner will not carry it up and down the stope face. If it is too frail it will not stand the rough usage to which

it is subjected. For all holes to be drilled in rock-breaking an attempt has been made to supply a burden director.

Development.—Although the director for stoping purposes was the earlier invention, the types of development directors are first dealt with. For inclined shafts similar directors are used as for haulage levels of large dimensions, e.g. 16 ft. by 10 ft. The number of holes in a round for such a haulage with large machines of the drifter type would be approximately 32, this figure varying slightly with the nature of the ground.

Two types of directors are in use for development, one for the "wedge" cut and the other for a "conical" cut. The wedge is favoured for inclined shafts and for resuing. The wedge director is a double-ended bar with the ends set to enclose the angle desired for the required depth of hole. The conical cut, with modifications, is generally used for all ordinary development ends. In over three years of close personal observation the author finds strong evidence for the systematic use of complete directors for all headings approximating to 7 ft. by 8 ft. when using 50 lb. rigged jack-hammers and 60% one-inch powder. More consistent breaking of long rounds is obtained and a smaller footage is drilled per foot advanced.

Though the term "director" is used in the singular, the complete director for development is really a set. The set of directors consists of three parts, one for the cut holes, one for the easers and one for the centre lifters, knee and shoulder holes. The outer lifters are undirected. The round consists of from 20 holes to 24 holes, according to the nature of the ground, and may have six or eight holes for the cut.

The director maintains the same longitudinal position on the centre pin for all holes. This position is fixed by trial before drilling is commenced. First, the collar clamp is fastened on the centre pin and the "cut" holes are drilled. The remaining holes are directed from this same position. In modern practice the tendency is to leave out the south "back" and "shoulder" holes to avoid breaking into the hanging strata.

In starting drilling the machine is lined up to a short dummy jumper or to a "starter." When the machine has been correctly set for a hole the clamp should be tightened before removing the director arm and dummy jumper. Particular care should be taken to tighten this clamp firmly before collaring the hole, or the work of directing will have to be repeated. It is advisable to drill the hole for a few inches and then re-set the machine so that it runs on to the jumper. This prevents the final direction of the hole deviating from the true.

The author says that holes should be drilled the exact depth decided upon according to the length of the round. To ensure this the borers should have a white paint mark drawn on them at a point corresponding to the depth of the hole, measured from the bit end. The machine should stop drilling when the paint mark reaches the collar of the hole. This prevents short holes and the consequent hanging up of the round, as well as the loss incurred by drilling some holes unnecessarily deep. Almost invariably the length of the round is governed by the shortest hole, so that too much stress cannot be laid upon this point.

The order of fuse timing and firing is most important and should be carefully studied by the person directing operations; this avoids misfires and cut-offs and gives efficient breaking. The rate of burning of the fuse will decide the lengths for each of the successive stages of blasting.

The following table gives a comparison of the total footage advanced and the costs per foot, exclusive of all shaft sinking, for the years 1923–1928 (Crown Mines figures). The director was brought into use between 1925 and 1926. The decrease in costs with the introduction of the director and the maintenance of a steady level thereafter is an indication of the increased efficiency.

Year.	*Footage advanced.*	*Cost per foot.*
	ft.	*s. d.*
1923	62,349	66 4
1924	76,996	62 8
1925	77,728	54 2
1926	75,103	51 5
1927	76,991	51 10
1928	93,301	46 8

The smaller holes drilled with jackhammer steel require to be directed even more closely. As smaller-diameter powder is placed in these holes, the force must be utilized with greater judgment in order to break an efficient round. But this smaller hole in itself means a saving in machine maintenance and drill steel, as well as in time.

The advantages to be derived from the use of directors in development are:

(1) Elimination of the human element in estimating burdens. Almost any type of man can be trained to break a round efficiently.

(2) Less wastage of time—no unnecessary footage is drilled.

(3) All holes drilled to the one length, giving no chance for a short hole to hang up the round.

(4) Less machine maintenance—fewer holes drilled.

(5) Less powder used—maximum burden is obtained with minimum powder.

(6) Less consumption of drill steel.

(7) Lower costs per foot advanced.

(8) A longer round more consistently obtained—more rapid development.

The disadvantages are few:

(1) No advantage can be taken of slips, faults, etc., occurring in the strata.

(2) Extra equipment required, namely, the directors.

(3) Time lost in lining up the machine and in directing the round.

This third disadvantage is entirely counterbalanced by the saving in time of advantage (2) and is in itself lessened as the miner becomes more accustomed to the director.

Resuing.—The resuing method of driving combines to a certain extent the difficulties of both development and stoping. The rounds require close supervision and careful use of the director if they are to advance satisfactorily.

Resuing is the direct response to the demand for cleaner mining. The reef channel is removed ahead of the footwall for about 10 ft. or 12 ft. In this advance heading, which is approximately 11 ft. wide on the dip, the north side is carried in line with what will eventually be the north side of the drive. When the footwall is lifted no blast of reef will take place in the advance heading except in special cases. This allows waste to be packed without any loss of reef in the packs. The track is

extended as the footwall advances. The south side widening will follow from the last through-connexion where this is convenient. Where not convenient a sump is sunk some 16 ft. deep from the track, keeping to the reef and not breaking the footwall. An air lift pump is then installed to deal with the water which accumulates from the machines. The waste from the footwall is built on stulls on the south side. This gives support to the south side and keeps the reef from development of as high grade as possible. Small openings, about 6 ft. wide, are left at intervals of not more than 30 ft. in this south side walling to afford access to the stope below when it reaches this position. When a fault or dyke is encountered, unless the throw of the fault or the width of the dyke is known to be small, it will be necessary to change immediately to ordinary driving until the reef is proved.

It is not advisable to stope out the north siding simultaneously with the south siding. If this is done the footwall frequently shatters and comes away, whilst pigstys installed are liable to disintegrate before the stoping faces reach them.

The advantages claimed for the resuing method are as follows :—

(1) Elimination of waste rock from the reef broken in development, thus improving the mine grade.

(2) Waste rock is retained for underground support.

(3) The necessary south siding is completed before stoping commences (Recommendation of the "Rock Burst Commission.")

(4) A better hanging is obtained over the drives with less timbering and maintenance.

(5) It gives greater safety.

The main disadvantage is the slow advance of any one end, making it necessary for many ends to be worked at one time to keep up the development footage of the mine. This disadvantage is sufficient to make resuing impracticable on many mines.

In resuing rounds the "cut" holes only are directed, the wedge cut being used. The remaining holes are broken to the excavation thus made. The burden given depends upon the ground and varies from 1½ feet to 2½ feet for each of the easer holes.

Resuing, in addition to providing the advantages already enumerated, yields a revenue which should cover the cost of development and provide a slight profit per foot advanced.

Stoping.—The burden director for stoping purposes was evolved by the Rock Drill Investigation Committee of the Central Mining and Investment Corporation, Limited, and was first introduced into Rand mining practice in 1922. Towards the end of 1923 the author commenced experiments on "breaking" and the use of directors, this work continuing almost uninterruptedly until the latter portion of 1928. From then on, the work was applied to the every-day practice of the mine, although no new experimental work was commenced.

Even after a considerable allowance has been made for improvements in the jackhammer, the increased efficiency since directors were installed is very marked. The better breaking conditions due to depth are practically entirely counteracted by the decreased stoping widths of present-day methods. The general use of the director was not enforced until 1925–26.

Crown Mines Figures.

In 1921.	Fathoms broken per machine shift,					0·55
,, 1922.	,,	,,	,,	,,	,,	0·59
,, 1923.	,,	,,	,,	,,	,,	1·03
,, 1924.	,,	,,	,,	,,	,,	1·74
,, 1925.	,,	,,	,,	,,	,,	2·04
,, 1926.	,,	,,	,,	,,	,,	2·31
,, 1927.	,,	,,	,,	,,	,,	2·25
,, 1928.	,,	,,	,,	,,	,,	2·31

The above figures are for the total fathomage of both Main Reef Leader and South Reef stopes, and illustrate the increase in efficiency after directors were introduced. This efficiency has been maintained at a fairly constant level in subsequent years by close attention to directors. Any slackness in the supervision of directors is marked by an almost immediate decreased efficiency.

The type of director in use on the Crown Mines, Ltd., has given satisfaction after a long period of trial. Made of ¾-in. or ⅞-in. wrought iron tubing, it weighs approximately 4 lb. The size of the director is denoted by the burden in inches which the director gives for a hole 42 in. deep.

An adjustable director is not fool-proof and does not give the complete standardization and absolute control obtainable with a fixed director.

A hole normally breaks beyond the socket at an angle substantially greater than a right angle. Thus for good breaking the face should be "free" for a sufficient distance beyond the hole to enable the sliping to have full effect, thus establishing the "angle of break." By "angle of break" is meant the angle between the line of the hole and the continuation of the face beyond the socket. If the face is not free beyond the hole the force of the explosion may be thrown back up the hole, causing a long socket to be left.

In using the director the following method recommends itself for consistency, simplicity, and accuracy. The miner places the director with the inner end of the pointer in the position he wishes to collar the hole. The director is then held by the "boy" whilst the miner drops a small stone from the hanging wall in order to get a mark vertically above the pointer of the director. He then throws a shadow with his lamp of the pointer through the mark on the hanging wall. The line of the shadow gives the direction for drilling; this line is then chalked on the face to the end of the pointer. A line joining the end of the pointer to the toe of the director gives the dip of the hole. The whole process occupies under one minute.

Alternatively, the machine boy is supplied with a separate director which he holds on marks made by the miner with his director. These marks are usually—a small circle for the collar of the hole and a "X," the position of the toe of the director. The boy's director would be held on these marks until the hole is about 6 inches deep.

When the machine boy is collaring the hole by the former method he should check the direction by dropping a stone from the chalk mark. This should strike the drill steel or its extension.

The depth of hole is, broadly speaking, governed by the stoping width. Except in very narrow widths (under 30 in.) a 42-in. hole gives the most satisfactory results—feet drilled per ton broken.

In deep-level mining the character of the rock becomes more constant in any one stope. After extensive experiments with directors and the plotting of thousands of holes, the following figures,

which have been found to be reliable in practice, were obtained, the average stope width being 40 inches.

One hole 42 in. deep will break :

Fathom.	*Burden.*	*Holes per fathom.*
0·122	with 24 in.	That is 8·2
0·138	,, 27 in.	,, ,, 7·25
0·153	,, 30 in.	,, ,, 6·54
0·168	,, 33 in.	,, ,, 5·95
0·184	,, 36 in.	,, ,, 5·43
0·199	,, 39 in.	,, ,, 5·03
0·214	,, 42 in.	,, ,, 4·67

The average hole has a charge of eight 4-in. sticks of gelignite. There are approximately 150 sticks in a 50-lb. case of gelignite (50% nitro-glycerine).

The above figures have been used by the author to obtain a "graph efficiency." This efficiency is the ratio obtained by dividing the number of holes per fathom theoretically required for the particular size of director used, by the number of holes actually drilled per fathom in the stope. In detail, the method of obtaining the above figures was as follows : A master director was used. The "master director" is a director with graduated telescopic limbs from which offsets can be measured to the face to well below the possible break, the offset from the bottom of the hole giving the burden on the hole. After blasting the director is used again to measure the offset from the socket. The length of socket and the amount of ground broken are factors from which the final size of the director to be used, as well as the strength of powder, are determined.

With the master director great accuracy is obtained, but only some 12 to 15 holes can be measured in a shift and two visits underground must be made. After the face fronting a hole had been carefully measured underground from the limb of the master director and plotted in the office, the hole was blasted and the face measured again, the area broken being then determined by means of a planimeter. Every hole was first plotted individually, then a series of 25, 50, or 100 holes was plotted. Care was taken in plotting any series of holes that only those with the same directed burden were massed together. In each case the area broken was expressed as a percentage of the area enclosed by the director burden and the length of the hole.

Careful analysis of a large number of holes quite uniformly showed that 63% of the area enclosed by the depth of hole and the burden of the director is broken when the correct size of burden director is used. This average figure for ground broken with the aid of the director is found to be very consistent over a very large number of holes and on different mines on the Rand. Undoubtedly, ground may be found where this figure does not hold, but for various sizes of burden directors on the Witwatersrand the consistency is remarkable. It seems reasonable, therefore, to assume that the "graph efficiency" offers an excellent basis for determining the proper burden for individual stopes throughout the Rand, and for comparing the work of different miners.

When placing a director in a stope for the first time, it is usual to note the partings of the hanging and footwall, and from this to judge the approximate size of the required director. This is then introduced into the stope and the results observed. By checking a series of holes with the master director the observer can ascertain whether he has chosen the correct size, or too large or too small a director, for the given stope.

The controlling agent should always be the master director, and all discrepancies, if occurring, should be explicable. Where graph efficiencies are 7% or more above or below 100%, a larger or smaller director respectively should give better results; alternatively a larger charge of powder is required. An increase in the grade of explosive, say, from 40% to 50% nitro-glycerine would only be economically justified if it gave an increase of over 4% in the graph efficiency for 1-inch powder.

The averge cost of drilling a hole 42 in. deep and 1 in. diameter is 2s. 8d. or 9d. per foot drilled, exclusive of a charge for white labour which entails an extra 6d. per hole. This is made up of : Air consumption; cost of drill steel; cost of sharpening drill steel; cost of distribution of drill steel; lubrication of the machine; machine maintenance; and coloured labour.

The general cost of explosive to break the ground is 1s. 1d. The total cost of one hole is 3s. 9d., and eight such holes are required to break one fathom of ground on the Crown Mines. A small increase in the cost of powder is of minor importance, because, if the hole is badly directed and given too great a burden, the charge will blow out, whilst if the burden is too light powder is wasted.

Hardness of the rock influences the drilling speed, but once the size of the director has been set, hardness does not enter into the calculations of the graph efficiency. The average ground broken per hole by a number of holes remains constant for any one director. Hence the "angle of break" remains approximately constant. For a series of 50 or more holes this angle appears to be constant within 3°. Knowing the depth of hole, the amount of ground broken can be fairly accurately obtained by measuring the socket and the angle of break, but not by either separately.

For measuring the angle of break a protractor was designed. The instrument is convenient to carry and can be used with rapidity. A little experience is necessary to avoid errors and to obtain proficiency in results. With the protractor as many as 80 to 100 holes can be measured in a single shift. This enables a close check to be kept on the breaking of the ground, and used in conjunction with the graph efficiencies determines the change to be made in the size of the director, immediately there is an appreciable alteration in the rock character.

The advantages of the burden director for stoping may be briefly summarized as :

(1) Entire elimination of the human element in determining the burden on any hole.

(2) Rapid training of a miner with but little experience to give efficient breaking results.

(3) Maximum burden possible is placed on every hole.

(4) Because of (3), the minimum footage per fathom is drilled.

(5) Machine maintenance costs per fathom broken are reduced.

(6) Low steel costs per fathom.

(7) Low air consumption per fathom.

(8) Less wastage of native labour—every hole drilled is efficient.

(9) Lower cost of native labour per fathom—no wasteful footage drilled.

The disadvantages are :

(1) When adhering closely to the director advantage cannot be taken of slips, faults, etc.

(2) A close check must be kept on results obtained to ensure the correct size of director in constant use.

(3) The director itself must be checked frequently in order that it be not used in a bent condition.

Further work must yet be done to enable the control of the director to be kept still closer without the employment of extra personnel. Maximum burden with fully sufficient powder gives the greatest efficiency, but to ensure the burden decided upon it is necessary that some automatic check on results should be obtained.

During the carrying out of these experiments other useful and pertinent observations were :

(1) Sockets appear to average 5 in. to 7 in. when the breaking efficiency is at its best.

(2) The largest burden possible for good breakage should be used in conjunction with an adequately heavy charge.

(3) This charge is 8 to 9 sticks of 4-in. × 1-in. powder.

(4) 50% gelignite gives greater efficiency than the lower grades, provided a maximum burden is used.

Much work has been done on the above points, and it is now definitely ascertained that all rock-breaking can be scientifically controlled. Maximum burdens and maximum breaking efficiency mean minimum costs.

GEOLOGICAL STRUCTURE AT THE KEELEY MINE, ONTARIO

At the annual general meeting of the Canadian Institute of Mining and Metallurgy, held in Ottawa last month, H. C. Boydell presented a paper on the geological structure disclosed in the Keeley mine, Ontario, and a summary of his paper is given here.

The Keeley mine is situated in the district if South Lorrain, some 16 miles south-east of Cobalt, Ontario, and reached from that centre either by branch line of the T. & N. O. railway or by what, for a mining camp, is a reasonably good road. Silver was first discovered in South Lorrain, in Woods' vein on Keeley property, in 1907 and the Keeley mine has been described by Knight and Bell. The total production to February 28, 1930, has been 10,760,107 oz. of silver and 1,285,434 lb. of cobalt.

The surface geology of South Lorrain was mapped by Burrows in 1908, whilst Knight has described the dome structure of the diabase sill at South Lorrain in greater detail. In briefest possible summarization, the geological setting of the Keeley property consists of Keewatin basaltic, and possibly andesitic, flows, showing pillow structure in places, intruded by lamprophyre dykes of Haileyburian age, and a diabase sill—the so-called Nipissing diabase—about 1,000 ft. thick, of Keweenawan age. These rocks are intersected by faults which became the loci of silver-bearing cobalt-nickel veins with their attendant suite of essentially arsenide minerals and native silver.

Of the attitude of the basaltic (and probably andesitic) lava flows which constitute the Keewatin rocks, little is known except that they appear to be steeply tilted. The economic geological structure disclosed in the mine workings consists essentially of Woods', 16, and 28 veins, all of which intersect one another as well as the upper surface of the diabase sill and, possibly, the lower one as well. The most important intersections, either from the point of view of actual, or potential, ore occurrence, are those of Woods', 16, and 28 veins with the upper, and, possibly, with the lower, Keewatin-diabase contacts. The numerous intersections form a structural complex that is at least unusual, if not unique, and lead in underground relations to complexities that require some experience and facility in vizualization in three dimensions to recognize and appreciate. Such intersections admit of interpretation by a combination of plans and vertical sections in the usual way, but, in order to present the complicated relations as plainly as possible, an isometric projection of the mine workings is given in the paper.

After going fully into the reasons and available evidence which led to the decision to explore the lower diabase contact at the Keeley mine the author gives the following summary of mine structure. The principal structural features of the Keeley property are three main faults, namely, Woods', 16, and 28, together with the Nipissing-diabase sill. The faults, subsequent to formation, became veins, and one of them, namely, 16, had a mica-lamprophyre dyke intruded along it. These faults (and the veins located on them) penetrate, and persist in, the upper part of the diabase sill so far as workings have extended. The writer's interpretation of the structural features is the following :

In the Keewatin rocks occupying what is now the Keeley mining property, there existed, prior to intrusion of the Nipissing-diabase sill, faults which became loci, subsequent to diabase-intrusion, of Nos. 1, 2, and 5 veins (of the present known lower-contact series). Subsequent to formation of those faults, and in Haileyburian (i.e., pre-Nipissing diabase) time, lamprophyre intrusion took place and a dyke of that rock followed the course of what, later, became No. 5 vein. At that time, Nos. 2 and 5 faults were continuous with what are known as Woods' and 16 faults (veins), respectively, in the, now, Keewatin cover of the diabase sill.

Intrusion of diabase subsequently occurred in Keweenawan time, occupying an interval of unknown length but one which, accepting the present as a key to the past, and in light of historical experience, which has probably covered, though unknowingly, cases of igneous intrusion, most likely took place very gradually and without catastrophic results. Intrusion lifted a portion of Keewatin rocks, of unknown thickness, the eroded remains of which now cover the sill for the greater part of its known extent. The diabase, in South Lorrain, was apparently intruded from N.N.W. to S.S.E. and moved its cover, apparently, approximately 500 ft. in the same general direction.

Following its emplacement, solidification of the diabase occurred together with attendant shrinkage and subsidences which affected the Keewatin cover too and caused local stresses that found relief in warping and faulting, which, in some cases, followed the general planes, pre-existing in the Keewatin cover, of Woods' and 16 faults, that were thus impressed on the diabase as well, to the extent of their actually entering and penetrating the sill, to some distance at least. Attendant on such subsidence, shrinkage, and faulting, was sympathetic readjustment of the Keewatin cover to fit its new position. Movement on Woods' fault had a lateral

component which, the writer suggests, resulted in transverse faulting of 16 fault with displacement of that portion known as 14 vein (not shown in the isometric projection). It is suggested, too, in present absence of evidence of any corresponding structure in the Keewatin basement, that subsidence of the diabase and movement on No. 16, resulted in formation of 18 fault, westward from Woods'.

According to the foregoing view, the age relations of the main faults (veins) would thus be, proceeding from older to younger: (1) Woods' and 16; (2) No. 28. The fact that there is no important faulting transverse to those veins is submitted as support of the idea, here advanced, that stresses due to readjustments in both Keewatin cover and sill, arising from solidification and subsidence of the latter, found relief in the general " planes " of pre-existing faults, with the exception of 28. The formation of this latter structural feature as due to subsidence, and therefore later (probably much later) than 16, is advanced somewhat hesitatingly by the writer, since nothing is disclosed in the mine workings to show that 28 displaces 16, as should theoretically be the case. At their intersection, the two veins seem to coalesce and form a fault zone of some extent, both in strike and dip, before they separate again. A later origin for 28 than for 16 explains, however, why 28 has, apparently, no continuation east of Woods', and why no vein corresponding to 28 has, as yet, been found at the lower contact.

Following solidification, partial or complete, and after an interval of unknown duration, there came mineralization of Woods', 16, 28, and the smaller faults. It is not within the scope of the present paper, which deals with structural features, to discuss the origin of the mineralizing and ore-forming solutions beyond stating that, in the writer's opinion, such genetic source was, for self-evident reasons, *not* the diabase itself. Any relation between minerals, ore, and diabase was merely that of children (and not necessarily successive ones even at that) of the same parent magma—in depths beneath. The apparent close relation between diabase and ore, demonstrated by ore never occurring far from the diabase sill, arises, so it is here submitted, from the ore-forming solutions having quite naturally followed the line of least resistance, as usual, which was, here, the structural channels previously opened up, or much emphasized, by intrusion of the sill.

As the writer interprets the evidence available at Keeley, the first mineralization took the form, in a general way, of calcite, sulpharsenides, and arsenides, which sealed the faults for the time being. This was followed, after an unknown length of time, which may not have been long, by re-opening of the veins and deposition of silver. The last phase was deposition of barren calcite. Such mineralization, and especially ore formation, was controlled, as usual, by pre-existing structure which formed abodes for the ore-shoots and took the form at Keeley of:

1.—Vein intersections (but not necessarily all).
2.—Folds in the diabase-Keewatin contact.
3.—Changes in direction (bends) of the veins.

It is the writer's opinion that, in the case of 16 and 28 veins, the ore-forming solutions ascended from a source, probably to westward.

Whilst the amount of silver won in the comparatively short time work has been going on at the Keeley lower contact has been only moderate, still, that amount, it may be safely said, together with the structure disclosed, and obtained, as it has been, at a depth so far below the Keewatin-diabase contact, gives promise of better results higher up, and, in the light of experience elsewhere, in the bottom of the diabase sill itself. The large extent of Keeley ground on the 1,448 ft. horizon (and above it) that has yet to be explored, offers, too, distinct encouragement in shape of possible discovery of other productive veins. In addition, exploration so far done has much theoretical and practical value in the way of information disclosed and its bearing on vital matters of finding ore.

Success at the Keeley will have significance for all interested in mining work in Ontario, since it will open up possibilities at Cobalt and Gowganda. Such Keeley exploration constitutes the first sustained attempt to find ore at the lower, as well as at the upper, contact. It is, further, a bona fide attempt on the part of a mining company to extend its life, not, on the principle " Distant fields look ever green," by seeking new mines (which all experience shows are so very hard to find), but by persistent searching of the original property, to find new ore-bodies or extensions of known ones, and so postpone the inevitable end that, unfortunately, must overtake all mines, big or small. The real value of the Keeley effort, apart from silver won or exploration done, is seen in the resumption of work by Mining Corporation at their Frontier mine and the effect in the South Lorrain district generally, where, in spite of dull times, there are now nearly as many men employed as ever there were; and, given success at Keeley, still palmier days are in store for the future.

TREATMENT OF HOLLINGER PRECIPITATE

In the *Bulletin* of the Institution of Mining and Metallurgy for March, Matthew Scott describes the production of fine gold from Hollinger precipitate. In his paper, full extracts from which are given here, the author says that the refining of precipitate is the final stage of all the processes involved in gold-mining and cyanide milling, by which the precious metal is at last obtained in a concentrated form, which can be accurately valued and marketed. The process described has been in satisfactory operation now for about two and a half years, during which time over twenty-five million dollars' value in fine gold has been produced, so that it may be reasonably held that it is successful.

In the mill solutions, calcium cyanide is used as the solvent and the precipitation of the gold and silver is made by the use of zinc dust and the Crowe vacuum process. The quantity of zinc added is 0·045 lb. per ton of solution of a value of $5·60, together with an addition of 0·01 lead acetate. It is of interest to note that of the zinc used for precipitation, the amount remaining with the precipitate is 9·8% of the total added to the solution. The measured solution, with the requisite zinc dust continuously added, is pumped through a pipe line to the filter presses on the top floor of the refinery building, the barren solution returning to the mill by gravity flow; so that all tangible values are contained in the one building,

thus minimizing risk of loss in case of fire and removing the chances of theft. The only entrance to the refinery, which is a building of heavy reinforced concrete construction, is guarded by a strong vault door.

The presses are dressed with double canvas and, when cleaning-up, the overcloths, after the precipitate has been removed, are soaked in weak muriatic acid to loosen the traces of precipitate still adhering in the interstices of the cloth, and are then scrubbed. This precipitate is filtered from the washing water and charged to the following clean-up. The average values in this hold-over are $3,000·00. New canvas is used first as undercloths, and these as required are made to replace discarded overcloths.

The precipitate as taken from the presses is then conveyed to another room where it is immediately put into process. Its composition may be taken as follows :—

	39·0% moisture	% on dry material.
Gold		35·0
Silver		7·2
Copper		1·4
Lead		9·3
Zinc		14·6
Iron		0·3
Alumina		0·5
Lime		11·7
Silica		0·7
Sulphur		4·4

In the usual acid treatment (acid or bisulphate) given to the precipitate preliminary to fluxing and melting, the end to be attained is a reduction of the large quantity of zinc present, so giving a residue more easily treated both from the fluxing and quantity points of view. The present zinc dust and vacuum methods of precipitation have removed to a large extent the reason for the foregoing and have made feasible a system of direct smelting in which calcination and accurate fluxing produce a bullion of ·960–970 fine (gold and silver) together with a cleaner slag.

An examination of the foregoing analysis shows that, the gold being present in such preponderating quantity, if the other metals were dissolved, leaving a gold residue, a very excellent shipping product would be obtained. Such is now being done, the gold being shipped as fine gold bars, i.e. over 992 fine in gold, the minute difference being silver. The zinc and lime are readily soluble in hydrochloric acid, and although lead is but very slowly soluble as metal, yet, as it exists in the precipitate as sulphide, a quick action is obtained. So that these three, zinc, lime, and lead, may be eliminated readily by treatment with hydrochloric acid, as also iron and alumina. The residue consists of gold, silver and copper, with small amounts of the foregoing. From then on the process is an adaptation of the sulphuric-acid parting process.

In the process of parting with sulphuric acid the ratio of gold to silver is maintained around 1 : 2½, although at the San Francisco Mint the ratio used to be, gold : silver as 2 : 3.

The possiblity of the solution of silver (and other metals) from a mixture in which gold is present in excess over the usual gold-silver ratio for parting purposes, lies in the fact that in zinc-gold precipitate from the cyanide process, these metals, gold and silver, are not alloyed, but exist as an intimate mixture of finely-divided material; so that the silver, etc., are immediately amenable to solution, since the acid is able to reach each particle without having to penetrate a mass of metal by solution, as is necessary in the ordinary parting process. This possibility of solution is the crux of the whole process and in the perception of it, together with the adaptation to practice, lies any claim to originality.

Hydrochloric Acid Treatment.—The method then consists first in the treatment of this precipitate with muriatic acid, which dissolves the lead, zinc, iron and lime. This acid is bought in tank car lots and stored in rubber-lined tanks from which is forced by air pressure to a measuring tank, also rubber-lined, suitably located for drawing-off to the treatment tank. The strength of the acid is 20° B containing 31·5% HCl. This acid is also piped from the measuring tank to the mill for de-liming filter cloths, at a considerable reduction in cost for acid. In practice the quantity of acid run into the treatment tank is equal to the wet weight of the precipitate, plus 100 lb. This has been found to be a satisfactory method of measuring the quantity required for the grade of precipitate usually treated and is sufficient to take care of the metals mentioned without causing a needless excess of acidity and consequent waste of acid.

The acid having been run into the tank, charging of the precipitate is commenced. Enamelled pails are used for this purpose, the contents of two of these, together weighing 45 lb., being charged, and time given for the frothing to subside. About two and a half hours are necessary to charge 1,500 lb. of wet precipitate. A strong evolution of hydrogen takes place, also sulphuretted hydrogen. These gases are allowed to pass through a water scrubbing tower to the atmosphere.

After the precipitate has been charged, steam is injected into the acid and the contents of the tank are agitated with air. The temperature having been raised to 160° F. and agitation continued for seventy-five minutes, the tank is then filled with hot water and decanted, using a rubber-lined pump which passes to a wooden filter press. The tank is filled six times with hot water and decanted before the solids are finally discharged to the press. It is necessary to keep the solution warm, else trouble caused by the crystallization of the lead chloride will ensue. Practically no copper is dissolved.

After the contents of the tank are discharged to the press, hot water at 125° F. is passed through the filter cakes for washing the residue clear of all solubles. Calcium chloride and zinc chloride pass away quickly, but lead chloride takes much longer before being finally eliminated.

The press is dressed with heavy English cotton twill covered with filter paper. The cloths have a long period of use, but after four months gradually become harder and more impervious, causing the pressure to rise and prolonging the time required for washing. This takes from one and a-half to four hours, depending on the condition of the cloth, and is considered finished when, on testing about 700 cc. of the wash water with potassium dichromate, no trace of lead precipitate is in evidence. It must not be forgotten that this reagent is only of value in testing after the effluent from the press has lost its acidity.

When washing is completed the press is blown

with air and finally discharged. In doing this, as each plate is drawn back, the paper is peeled from the residue in the frame and placed in a pan for burning, so that the product from this step is a clean material for the following sulphuric-acid treatment.

Whereas the original precipitate is bluish-black in colour, the residue from the first treatment tends towards brownish-black. An average figure for moisture in the raw precipitate is 39% and in the hydrochloric acid residue it varies from 36–44%. It may be taken approximately that 100 lb. of dry raw precipitate will give 47 lb. of dry HCl residue. The composition of this residue is as follows, on a dry basis :—

	%
Gold	75·85
Silver	15·37
Copper	2·27
Lead	0·15
Zinc	1·54
Iron and Alumina	0·14
Lime (CaO)	0·32
Silica	0·46
Sulphur	0·76

The following figures give the percentage elimination from the raw precipitate : lead 99·2%, zinc 95·0%, lime 98·7%, iron and alumina 92·0%.

The residue is weighed into pans, placed in an oven, and dried sufficiently to remove about two-thirds of the moisture. This is necessary as the presence of too much water, coupled with that formed by the solution of silver in sulphuric acid, would dilute the acid considerably and cause damage to the steel pans in which the residue is boiled.

The filtrate from the hydrochloric acid is referred to later on.

Sulphuric Acid Treatment.—This is really the ordinary process of sulphuric-acid parting with the difference that the material to be boiled is not the dense gold-silver alloy usually treated, but is finely divided and partly agglomerated in drying into soft porous lumps, and so being more voluminous requires a larger receptacle, weight for weight.

It is charged into pans made of half-inch steel plate, 3 ft. by 5 ft. by 15 in. deep, fitted with covers and a lead flue pipe, the whole being placed on electric heaters. Each pan contains about 650 lb. of acid from the previous boiling. A maximum charge for boiling is considered to be 400 lb. wet weight of residue, although 460 lb. have been treated, but it is not advantageous to have too thick a layer on the bottom of the pan.

As the temperature rises, an effervescence takes place, caused by the solution of the silver emitting sulphurous anhydride, which however has never caused any trouble by rising too high ; but the presence of paper is to be guarded against, since it will cause a heavy black froth due to the action of the acid dehydrating the paper, this carbonization being very objectionable. While the temperature rises finally to 520° F., the contents of the pan are rabbled every half hour, the silver dissolves, the anhydrous sulphate of copper partly dissolves and partly settles with the gold, and the lead, converted into sulphate, makes the acid turbid.

The colour of the precipitate residue gradually changes through chocolate-brown until it finally assumes the rich brown orange colour of parted gold. After maintaining the temperature for about one hour the acid is syphoned off into a tank containing warm water, where the silver and copper remain in solution, and the lead, together with any fine particles of gold, which may have been drawn over, settle to the bottom. Fresh acid is then run into the pans and after rabbling, the temperature is again raised to 520° F., maintained at this point for about one hour, and the acid syphoned off once more into the same tank as previously.

More acid is now run into the pans for cooling off and clearing fume, and the gold is then removed with flat scoops and dropped through a tile-lined lead funnel backed with steel into a tank underneath containing hot water. The copper and any silver present go into solution, and the gold settles to the bottom of the tank. The gold is now granular, with a few small lumps about the size of a hazel nut, which however are quite friable, and is of a beautiful rich colour ; it settles easily and rapidly, but cannot be pumped. The tank has a bottom-discharge into a filter box underneath, a lead pump with rubber diaphragms creating the necessary suction.

The filtrate is discharged into the same tank which received the syphoned acid from the pans, the gold is washed from the tank with hot water and the washing is continued in the filter until no trace of silver is shown on testing.

At first difficulty was encountered because of traces of lead remaining with the gold, which cause brittleness in the bars after melting. This difficulty was overcome by giving the fine gold residue in the filter two washes with the necessary quantity of sodium acetate, which dissolves the lead sulphate. After washing the gold residue free from any lead acetate, it is removed from the filter and placed in pans in the drying oven.

Melting the Gold.—When the gold is dried, it is weighed out into enamelled pails in quantities for melting and charged to an oil-fired tilting furnace, together with about 7 lb. of flux composed of silica, borax, and manganese dioxide, using a graphite crucible. The crucible is necessarily much larger than is actually required for the size of the bar finally poured. Briquetting could be used, but is not practised because of spilling, the time element, and the extra handling of such a valuable product. The time required to melt a bar, 1,500 oz., is about forty minutes. In practice the gold is withdrawn from the oven before it is quite dry, sufficient moisture being present to prevent dusting. Too much moisture would of course soon demolish the crucible and also cause blowing of the charge by the steam generated. A crucible is used for about twenty meltings, after which it is removed, although it may sometimes be good for a few more ; experience dictates this procedure in preference to a spill.

When the gold is melted, the burner is shut off, the furnace temperature slightly reduced, and the melt poured into a cast-iron mould which has been rubbed with graphite and oil and warmed. When set, the mould is tipped, the gold bar placed in water, the slag removed, and the bar cleaned, sampled and weighed. The bar obtained is now fine gold, ·994 to ·997 fine, with all the usual characteristics of the metal, and is immediately shipped to the Mint.

Returning now to a consideration of the filtrates, there are the sulphate liquors from the gold boiling containing silver and copper in solution with a

lead sulphate sediment, also the chloride liquors from the hydrochloric acid treatment.

Sulphate Liquors.—The silver-copper solution is syphoned off into another tank, and the silver is then precipitated with aluminium powder. One pound of aluminium will precipitate 11·6 lb. of silver or 3·4 lb. of copper. An approximate quantity is added to the tank, the solution being agitated by air; and then the tank is finished off by small additions and testing for silver.

The silver is allowed to settle and the clear liquor syphoned off into another tank. The liquor remaining with the silver is diluted with hot water; then the contents of the tank are pumped to a filter-press and the silver is discharged after washing.

The grey precipitate is placed in pans and dried, after which it is briquetted and charged to a graphite crucible in a small oil-fired tilting furnace, and melted with some soda and borax. The silver obtained is free from gold and about ·985 fine.

A small amount of silver passes with the copper solution, but is recovered with the copper, the total of this silver for one year being 248 oz. The copper is also precipitated with aluminium powder, which gives a very clean precipitate. The copper is periodically filtered off, dried, and melted into tough cake copper, and at present is accumulating until sufficient is collected for shipment.

The lead sulphate sediment settled from the decanted boiling sulphuric acid is washed down into a small lead-lined vat, agitated with boiling water and allowed to settle. The clear liquor passes to the silver tank. The sediment is again stirred up with hot water and about 5 lb. of zinc dust are added. This reduces most of the lead sulphate to lead and removes the slimy nature of the sediment so that it is possible to filter it easily in a small suction-box filter. This sediment is held over and goes to the general scavenger run.

Chloride Liquors.—The sulphate liquors decanted from the copper tank are run into the tank which will receive the chloride filtrates from the hydrochloric acid treatment in the next clean-up. Here the lead chloride is precipitated as lead sulphate, which settles rapidly and clarifies the solution. The clear liquor is run to waste and the lead sulphate passed to a filter press, where it is washed, and then discharged. It is melted in the scavenger campaign.

Scavenger Campaign.—This campaign entails the running of a small water-jacketted cupola about twice a month at the most, depending on the materials to be treated. The duration of the run is from four to five hours, and besides the lead sulphate, all slags, floor sweepings, old crucibles, ashes from old filter cloths, etc., are smelted with litharge to produce a lead bullion.

High-grade ore found in the mine is sent direct to the refinery, also special high-grade cleanings from the mill. These are also passed to the cupola, so that, generally speaking, the only waste passing from the building is the solution already mentioned and the slag from the cupola.

The slag losses for twelve months were $259·00 from the treatment of refinery products and high-grade materials valued at $29,000·00. So that the total unrecovered loss in solutions and slags for one year was $326·00. The grade of the slag is approximately $10·00 per ton.

The lead bullion is cupelled every four weeks in an oil-fired English cupellation furnace and a mixed gold-silver bar of bullion is recovered.

General.—Of the gold received in the form of precipitate over 98·5% is shipped as fine gold. The difference (1·5%) together with the gold and silver received in high-grade materials is shipped as doré bars, and of the silver, received in precipitate form, 95% is shipped in bars free from gold. Cost per ounce troy of gold shipped, from precipitate to metal, is 6·18 cents. Cost per ounce troy fine metal shipped (i.e. gold and silver) is 5·14 cents. Cost per ounce troy of fine metal, including refinery cost and mint charges, is 5·66 cents. The average cost over three years previous to the installation of the present process, and when output was greater, was 7·87 cents per oz. of fine metal bullion, including refinery costs and Mint charges.

Flotation of Gold in Copper Ores.—The flotation of minor gold in large-scale copper concentrators is treated by E. S. Leaver and J. A. Woolf in Technical Publication No. 410 of the American Institute of Mining and Metallurgical Engineers. The authors point out that the amount of gold that occurs in a ton of milling ore from most of the large-scale copper mines is so small that unusual care and special attention are necessary to recover it. In some cases the gold is not considered important enough to warrant daily assays of the various products. Considering the large tonnage of copper ores that are now concentrated by flotation, as computed in a recent review, the gross gold content is surprisingly large, probably amounting to over 10 million dollars per year in the United States. The indications are that in many of the copper-milling operations with gold content under $1 per ton, only 50% of the gold is recovered in the flotation concentrates. Lime is generally used as a depressant for pyrite in the flotation circuit. The authors have shown that high lime or a solution high in calcium ions is also a depressant for gold. Their experiments on several well-known ores show that by careful regulation of the alkalinity of the mill solutions, a higher flotation recovery of the gold can be obtained, together with equally good copper recovery in a good grade of copper concentrates.

In cyanidation for the recovery of gold, the best accepted practice demands that the mill solutions be tested and regulated by simple chemical reactions at definite periods during treatment or with each change in the treatment. It is similarly important for the recovery of gold that the solution in the flotation circuit be analyzed for calcium ions at regular periods and at each step in the flotation practice. The lime should be added when and where needed and not in excessive amounts at the head of the mill.

Experiments with ore from the Walker mine in Plumas County, California, showed that:—

(1) The residue from aqua regia treatment of either the mill tailings or flotation feed contained about 10 c. in gold per ton, indicating that the siliceous gangue when crushed to the size of the flotation feed still retained at least 10 c. in gold per ton.

(2) The magnetic portion of the mill tailings, composed largely of magnetite and included grains of pyrite, contained gold equivalent to 3½ c. per ton of tailings. Finer grinding of the ore should liberate most of the sulphide grains and render a portion of this gold amenable to flotation.

(3) Nearly pure concentrates of chalcopyrite, pyrite, or pyrrhotite obtained from specimens of

massive sulphides contained enough gold to account for only a small percentage of that recovered in the mill concentrates. This indicated either that the disseminated sulphides occurring in the mill feed carried more gold than did the massive variety of sulphides or that most of the gold occurs as free gold. An examination of the lime scale which forms on the sides of the flotation cells and launders indicated that a considerable percentage of the gold occurred as metallic gold.

(4) The silver followed the copper closely during flotation, and most of it was probably associated with the copper sulphides.

(5) The gold did not follow the copper during flotation as closely as did the silver. It appeared to be more or less depressed when the pyrite is depressed, which suggested that depressing agents for pyrite may also have an adverse effect on flotation of metallic gold.

An extended series of experiments, fully recorded in the paper, forced the authors to the following conclusions :—

(1) Lime is a noticeably active depressant for free gold during flotation if the alkalinity of solution circuit is 10 pH or above.

(2) In the flotation of base-metal ores containing gold as a by-product, careful regulation of the lime, avoiding excess, will increase the gold recovery.

(3) Lime is extensively used for depressing pyrite during flotation for the recovery of copper sulphide minerals, resulting in a higher grade of copper concentrates with only slight loss in the percentage of copper recovery.

(4) Provided the pyrite is crushed fine enough to free the gold, by low lime alkalinity in flotation circuit, most of the pyrite may be depressed and a high percentage of the gold floated with the copper sulphides.

(5) The optimum range of alkalinity due to lime for the flotation of gold is 7·5 to 10 pH. This range is also best for the flotation of copper and silver minerals.

(6) Ores with low ratio of pyrite to copper sulphide and containing under one dollar of free gold per ton, by control of the flotation circuit that assures low alkalinity, gave 25% copper concentrates containing 90 +% of the copper and 80 +% of the gold.

(7) Ores with high percentage of pyrite, and lean in copper sulphides and gold as a nominal by-product, offer low-grade concentrates unless the percentage of gold recovery is sacrificed.

(8) In the flotation of oxidized base-metal ores in which a sulphidizing reagent is used, sodium sulphide gives a much higher percentage of gold recovery than calcium sulphide or polysulphide ; calcium salts depress gold.

(9) Results warrant further research and more detailed investigation at each copper concentrator in which the gross gold lost offers a problem.

SHORT NOTICES

Top-Slicing.—The top-slicing method of stoping as used in the South-Western United States is described by M. J. Elsing in *Engineering and Mining World* for March.

Underground Haulage.—The relative merits of storage-battery and trolley locomotives for underground haulage are discussed by G. C. Newton in *Engineering and Mining World* for March.

Bore-Hole Pumping.—In a paper read before the Institution of Mechanical Engineers on March 20, R. S. Allen and W. E. W. Millington dealt chiefly with pumping from bore-holes in a paper on modern methods of raising water from underground sources.

Leaching of Bornite.—J. D. Sullivan deals with the chemistry of leaching bornite in Technical Paper 486 of the United States Bureau of Mines.

Retreatment of Carbonaceous Slime Tailings.—In Technical Paper 481 of the United States Bureau of Mines, E. S. Leaver and J. A. Woolf describe a proposed method of retreatment for Mother Lode (California) carbonaceous slime tailings.

Dwight-Lloyd Process.—The importance of the Dwight-Lloyd process in the treatment of the Rammelsberger ores is discussed by W. Sauerbrey in *Metall und Erz*, 1 Marzheft.

Flotation.—A. M. Gaudin, J. O. Groh, and H. B. Henderson give the results of a study on the effect of particle size on flotation in Technical Paper No. 414 of the American Institute of Mining and Metallurgical Engineers.

Grinding Time and Dilution.—The effect of grinding time and pulp dilution on flotation is discussed by A. W. Fahrenwald and L. T. Abele in *Engineering and Mining World* for March.

Ball-Mill Efficiency.—Technical Paper No. 416 of the American Institute of Mining and Metallurgical Engineers forms No. 2 of a series of ball-mill studies by A. W. Fahrenwald, G. W. Hammar, H. E. Lee, and W. W. Staley, and deals with thermal determinations of ball-mill efficiency.

Copper Refining.—In *Engineering and Mining World* for March, W. Hart describes the methods of copper refining used at Mount Lyell, Tasmania.

Beryllium.—Dr. G. Malcolm Dyson outlines the chemistry and metallurgy of beryllium in *Chemical Age* for March 14.

Treatment of Beryl.—In *Industrial and Engineering Chemistry* for March, C. James, H. C. Fogg, and E. D. Coughlin, describe the extraction of beryllium, caesium, and rubidium from beryl.

Electrical Prospecting.—H. Lundberg and T. Zuschlag describe a new measuring procedure, permitting potential drop ratio determinations, in Technical Publication No. 415 of the American Institute of Mining and Metallurgical Engineers.

Chambishi, Northern Rhodesia.—The geology and ore-deposits at Chambishi, Northern Rhodesia, are described by D. M. Davidson in *Economic Geology* for March-April.

Vlakfontein Nickel.—R. D. Hoffman describes the Vlakfontein nickel deposits in the Rustenberg area of the Transvaal in *Economic Geology* for March-April.

Snowflake Mine, British Columbia.—A tin-silver vein in the Snowflake mine, British Columbia, is described by Dr. H. C. Gunning in *Economic Geology* for March-April.

Mining in Newfoundland.—F. W. Foote indicates the active mines in Newfoundland in an article in *Engineering and Mining World* for March.

Wyoming Coals.—Technical Paper 484 of the United States Bureau of Mines deals with the composition of Wyoming coals.

Black Hills, Dakota.—The *Black Hills Engineer* for January is devoted to a description of the industries of the district.

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.*

24,260 of 1929 (317,399). H. H. STOUT, Arizona. For the purposes of refining, molten copper is first oxidized by any of the usual methods and then reduced in a special vessel before casting.

30,124 of 1929 (342,682). W. A. HARRIS, London. The passage of material between jig compartments is improved by adjustable communicating apertures or channels below the working water level of the apparatus.

30,402 of 1929 (343,047). METALLGESELLSCHAFT A.-G. and H. KLENCKE, Frankfurt-on-Main, Germany. A specially designed Dwight-Lloyd apparatus of small width is used for the complete roasting of highly sulphidic ores. In it, the rapid escape of heat from the charge is so well ensured that the heat of reaction is no longer sufficient to produce premature sintering.

30,867 of 1929 (340,641). FRIED. KRUPP A.-G. FRIEDRICH-ALFRED-HUTTE, Rheinhausen, Germany. Sponge iron is obtained by forcing a current of blast-furnace gas through a subsidiary shaft containing iron ore.

32,200 of 1929 (342,293). DR. C. GOETZ, Berlin. By treating bituminous ores in low temperature retorts at about 500° C. only the bitumen is removed, the ore minerals remaining to all practical purposes entirely unchanged and in a form suitable for subsequent concentration.

34,347 of 1929 (343,130). J. G. CLOKE, Tavistock. Means for the crushing of ores by differential abrasive milling.

37,632 of 1929 (340,739). B. M. S. KALLING and C. VON DELWIG, Avesta, Sweden. Iron ore is reduced, after mixing with carbon, without smelting, using electric heating.

2,795 of 1930 (342,130). HARDINGE COMPANY, INC., New York. Improvements in grinding mills.

14,146 of 1930 (343,398). OHIO ELECTRIC MANUFACTURING CO., Cleveland, Ohio. By means of a specially designed cylinder the magnetic conveyance of elongated magnetic articles has been facilitated.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 724, Salisbury House, London, E.C.2.

The Geology of Malaya. By J. B. SCRIVENOR. Cloth, octavo, 217 pages, illustrated. Price 16s. London: Macmillan and Co.

Lehrbuch der Bergwirtschaft. By Dipl.-Berging. K. KEGEL. Cloth, large octavo, 653 pages, illustrated. Price 48 RM. Berlin: Julius Springer.

Volcanoes. By Dr. G. W. TYRRELL. Home University Library. Cloth, octavo, 252 pages, illustrated. Price 2s. 6d. London: Thornton Butterworth.

Technical Methods of Chemical Analysis, Vol. 3. 2nd edition, 1931. By Dr. C. A. KEANE and Dr. P. C. L. THORNE. Cloth, octavo, 678 pages, illustrated. Price 63s. London: Gunney and Jackson.

Tin: World Statistics: 1931. Cloth, pocket size. Price 2s. 6d. London: Anglo-Oriental Mining Corporation.

Psychometric Tables, with special reference to Deep Mining Ventilation. By C. W. B. JEPPE. Paper covers, 30 pages. Price 3s. 6d. To accompany a paper presented to the Chemical, Metallurgical, and Mining Society of South Africa on October 22 last.

The Inflammation of Coal Dusts: The effect of the presence of firedamp. By T. N. MASON and R. V. WHEELER. Safety in Mines Research Board Paper No. 64. Paper covers, 33 pages, illustrated. Price 6d. London: H.M. Stationery Office.

A Flame Safety-Lamp of High Candle-Power. By D. W. WOODHEAD. Safety in Mines Research Board Paper No. 65. Paper covers, 15 pages, illustrated. Price 6d. London: H.M. Stationery Office.

Lord Mayor's Fund for the relief of distressed mining areas in England and Wales. 2nd Interim Report. Paper covers, 135 pages. Price 1s. London: H.M. Stationery Office.

Applied Geophysics. A brief survey of apparatus and methods. By H. SHAW and others. Paper covers, 101 pages, illustrated. Price 2s. London: H.M. Stationery Office.

Mineral Production of Canada, 1930. Preliminary Report. Paper covers, 39 pages. Ottawa: Dominion Bureau of Statistics.

Mineral Production of Quebec, 1930. Preliminary Statement. Paper covers, 9 pages. Quebec: Bureau of Mines.

Nova Scotia: Annual Report on the Mines, 1930. Paper covers, 322 pages, illustrated. Halifax: Department of Public Works and Mines.

Uganda: Geological Survey Summary of Progress, 1919–1929. Paper folio, 44 pages, illustrated, with maps. Price 4s. London: Crown Agents for the Colonies.

Tanganyika Territory: Geological Survey Annual Report, 1929. Paper covers, 60 pages, illustrated, with map. Price 4s. London: Crown Agent for the Colonies.

Empire Mining and Metallurgical Congress, 1930. *Proceedings.* 4 vols., cloth bound. Price 42s., postage 4s. Johannesburg: Congress Secretary.

California: Names and Definitions of Geologic Units. United States Geological Survey Bulletin 826. Paper covers, 97 pages. Price 20 cents. Washington: Superintendent of Documents.

Bibliography of North American Geology, 1919–1928. United States Geological Survey Bulletin 823. Paper covers, 1,005 pages. Price $1·25. Washington: Superintendent of Documents.

Mineral Resources of the United States, 1929. Part II, pp. 209–218. Barytes and Barium Products, by R. M. SANTMYERS and B. H. STODDARD; pp. 219–227, Talc and Soapstone, by O. BOWLES and B. H. STODDARD; pp. 229–266, Stone, by A. T. COONS; pp. 267–298, Lime, by A. T. COONS; pp. 319–340, Natural Gas, by G. R. HOPKINS and H. BACKUS. Paper covers. Washington: Superintendent of Documents.

University of Missouri, School of Mines and Metallurgy, Rolla. Catalogue Number of *Bulletin* for 1930–31 sessions. Rolla, Missouri.

The Coming Rise in Gold Shares. By L. L. ANGAS. Paper folio, 16 pages. Price 5s. London: Specialized Business Services.

COMPANY REPORTS

Crown Mines.—This company was formed in 1892, the present name being adopted in 1909, when many adjoining properties were absorbed. The company works a gold mining property in the Central Rand. The report for 1930 shows that during the year 3,348,531 tons of ore was mined and, after sorting 442,331 tons of waste, 2,906,200 tons was sent to the mill, a quantity 262,000 tons greater than the record tonnage of the previous year. The gold recovered totalled 924,299 oz., worth £3,920,750, and silver and osmiridium recovered brought the revenue up to £3,929,652. In addition 10,555 oz. of gold, realizing £44,772, were recovered from discarded zinc boxes, the total revenue being £3,974,424, or 27s. 4d. per ton milled, a decrease of 3d. per ton milled when compared with the previous year. Working costs amounted to 20s. 3d. per ton and the total working profit was £1,034,918, or 7s. 1d. per ton, as compared with £947,113 and 7s. 2d. per ton in the year before. Dividends totalling £636,567, equal to 67½%, were paid during the year. The available ore reserves at the end of the period were estimated to be 9,974,980 tons, averaging 6·56 dwt. over a stoping width of 46·6 in., as compared with 8,896,270 tons, averaging 6·45 dwt., at the end of 1929. No. 16a shaft was completed during the year and development is now proceeding from it on several levels to a depth of 5,600 ft. Results of development were very favourable and record footages were attained.

Robinson Deep.—This company was formed in 1915 and in March, 1930, acquired the whole of the mining rights of Village Deep, Ltd., together with certain plant and machinery. The report for the year 1930 shows that 1,515,864 tons of ore was mined, of which 176,864 tons was sorted as waste and 1,339,000 tons sent to the mill. The tonnage milled shows an increase of 419,100 which includes 280,000 tons treated at the Village Deep plant up to June 30 last, after which all tonnage was treated by the Robinson Deep plant, the capacity of which had meanwhile been increased to deal with 95,000 tons monthly. The gold recovered from the mill totalled 365,781 oz., worth £1,554,112 or 23s. 3d. per ton milled. Working costs amounted to £1,289,707 and the working profit was £261,771, as compared with £172,830 in the previous year. During the year £132,180 was distributed as dividends, equal to £75,000 on the " A " shares and £57,180 on the " B " shares. The ore reserves fully developed at the end of the year were estimated to be 2,397,000 tons, averaging 5·9 dwt. over 58 in. Compared with the previous year, due to the absorption of the Village Deep, this shows an increase of 1,090,000 tons and a decrease of 0·1 dwt. in value and 2 in. in stoping width.

Simmer and Jack Mines.—This company has worked a gold property in the East-Central Rand since 1887. The report for the year 1930 shows that 1,083,457 tons was mined during the year and, after sorting 166,757 tons as waste, 916,700 tons was went to the mill, where 250,486 oz. of gold, worth £1,064,190, was recovered. Working costs amounted to £956,144 and the working profit was £106,144, or 2s. 4d. per ton, as compared with £69,988 and 1s. 7d. per ton in the previous year. A dividend of 5%, paid during the year, absorbed £31,250. The ore reserves at the end of the period under review were estimated to be 1,625,000 tons, averaging 6·0 dwt. over a stoping width of 51 in. Compared with the previous year there is an increase of 44,000 tons and of 0·1 dwt. in value over the same stoping width. The improved results obtained during the year are substantially due to the successful introduction of the top-cut method of resuing, the application of which has been steadily extended.

Government Gold Mining Areas.—This company was formed in 1910 to develop gold mining property lying to the dip of New Modderfontein and Modderfontein B and is controlled by the Johannesburg Consolidated group. The report for the year 1930 shows that during the year 2,932,864 tons of ore was mined and, after sorting 496,364 tons as waste, 2,436,500 tons was sent to the mill. Ore crushed in the mill amounted to 2,438,000 tons and this yielded 1,107,094 oz. gold, worth £4,702,638, and osmiridium worth £13,248 was also recovered. The total working costs amounted to £2,015,888 and the working profit to £2,686,750, or 22s. 0·5d. per ton, as compared with £2,636,545 and 21s. 10d. per ton in the previous year. During the year £1,260,000 was distributed as dividends, equal to 90%. The ore reserves at the end of the period under review were estimated to be 10,840,000 tons with an average value of 8·9 dwt. over a stoping width of 61 in. These figures compare with 10,876,000 tons of the same value as at the end of 1929, but once again the stoping width has decreased by 2 in. In addition it is stated that while the development of the North-East (No. 2) Section has been advanced rapidly, the percentage payability and the channel width are not up to the average of the mine.

New State Areas.—This company, belonging to the Johannesburg Consolidated group, was formed in 1918 to work a Government lease-area in the Far East Rand to the south-east of Government Areas. The report for 1930 shows that 1,312,100 tons was hoisted from the mine and, after sorting out waste, 1,103,760 tons was sent to the crusher where, after discarding more waste, 930,000 tons was milled. The gold recovered totalled 445,937 oz., worth £1,894,219. Working costs amounted to £1,007,468 and the working profit to £866,751, or 19s. 0·8d. per ton, as compared with £705,178 and 15s. 4·4d. in 1929. Dividends paid during the year absorbed £264,956, equal to 17½%. The ore reserves at the end of the period under review were estimated to be 2,716,000 tons, averaging 8·9 dwt. over 50 in. stoping width, as compared with 2,696,000 tons of the same value and width the year before. The year's results constitute a record, particularly as regards yield per ton. Some alterations and additions are being made to the reduction plant.

Van Ryn Deep.—This company, also belonging to the Johannesburg Consolidated group, was formed in 1902 to work a property in the Far East Rand. The report for the year 1930 shows that 1,073,530 tons of ore was sent to the mill where 302,480 tons was sorted as waste. After taking 50 tons from stock, 771,000 tons was crushed, yielding 297,604 oz. of gold, worth £1,264,140. Osmiridium recovered brought the revenue up to £1,265,839. Working costs amounted to £804,001 and the working profit to £460,139, or 11s. 11·2d. per ton, as compared with £497,626 and 13s. 3·7d. per ton a year before. Dividends paid during the year absorbed £359,068, equal to 30%. The ore reserves at the end of 1930 were estimated to be 2,854,000 tons, averaging 7 dwt. over a stoping width of 48 in., as compared with 3,022,000 tons,

averaging 7·3 dwt. over 50 in., at the end of the previous year. It is stated that some good values have been found in a reef 200 ft. above the Main Reef Leader, but that it is too soon to estimate the significance of this discovery. Additional pumping plant has been installed to deal with water expected in the workings when the New Kleinfontein mine closes down.

Randfontein Estates.—This company, originally formed in 1889, now belongs to the Johannesburg Consolidated group. The company operates a gold mining property in the Far West Rand and an account of the mine and its equipment by the consulting engineer, Mr. G. H. Beatty, was given in the last issue of the MAGAZINE. The report for the year 1930 shows that 2,653,364 tons was sent to the crusher station, of which 112,591 tons came from development, 2,357,314 tons from the stopes, and 183,459 tons from reclamation. After sorting out waste, 2,573,000 tons of ore was milled, the gold recovered totalling 652,607 oz., worth £2,772,097. Working costs amounted to £2,366,265 and the working profit for the year was £412,520, or 3s. 2·4d. per ton, as compared with £246,705 in the previous year. Debenture interest absorbed £22,515 and £399,133 was appropriated for capital expenditure and redemption of debentures. The ore reserves at the end of 1930 were estimated to be 5,293,000 tons, averaging 6·0 dwt. over a stoping width of 41 in., as compared with 4,505,000 tons, averaging 5·8 dwt. over the same stoping width, at the end of the previous year. It is expected that the No. 2 North Shaft will be completed at 4,600 ft. in May and that it will be in commission a few months later.

Langlaagte Estate and Gold.—This company belongs to the Johannesburg Consolidated group and was formed in 1888 to work a gold mine in the Central Rand. The report for the year 1930 shows that 981,193 tons of ore was mined and, after sorting 22,193 tons of waste and adding 2,500 tons taken from the Estate section, 961,500 tons of ore was crushed. The gold recovered amounted to 326,413 oz., worth £1,386,513, and osmiridium recovered brought the revenue up to £1,387,391. Working costs amounted to £1,004,615 and the working profit to £385,645 which shows an increase of £73,800 when compared with the previous year. Dividends paid during the year absorbed £303,967, equal to 20%. The ore reserves at the end of the year were estimated to be 1,530,000 tons, averaging 7·4 dwt. over a stoping width of 43 in., as compared with 1,596,000 tons of the same value, but over 42 in., at the end of the previous year. The scheme whereby the hoisting in the West Shaft is divided into two lifts has been completed and an underground sorting plant has been installed on the transfer level. Exploration work which is being undertaken in old areas is having good results.

Witwatersrand Gold.—This company also belongs to the Johannesburg Consolidated group and was formed in 1887 to work a gold property on the East Rand. It is usually known as Knight's. The report for the year ended December 31 last shows that 723,743 tons of ore was mined and, after sorting 64,243 tons as waste, 659,500 tons was sent to the mill, where 145,137 oz. of gold was recovered, worth £616,504. The working costs amounted to £579,597 and the working profit to £37,955, or 1s. 1·8d. per ton, as compared with £15,347, or 6d. per ton, for 1929. Dividends paid during the year absorbed £46,962, equal to 10%. The ore reserves at the end of the period under review were estimated to be 391,000 tons, averaging 5·5 dwt. over a stoping width of 54 in., as compared with 372,000 tons, value 5·4 dwt., over 53 in., at the end of 1929. A large proportion of the ore mined during the year was taken from old workings, only 152,000 tons being mined in blocks included in the ore reserves.

Durban Roodepoort Deep.—This company was formed in 1895 to work a deep-level property in the Middle West Rand. The report for the year 1930 shows that 594,900 tons of ore was sent to the mill and, after sorting 75,400 tons as waste, 519,500 tons of ore was treated, yielding 172,562 oz. gold, worth £732,241. Silver and osmiridium brought the revenue up to £733,756. Working costs amounted to £667,073 and the working profit was £66,683, or 2s. 7d. per ton, as compared with £46,640 and 1s. 11d. per ton in 1929. Dividends paid during the year absorbed £28,125, equal to 7½%. The available ore reserves at the end of the period under review were estimated to be 2,043,100 tons, averaging 6·98 dwt. over a width of 47·2 in., as compared with 1,626,800 tons and 7·4 dwt. at the end of 1929. The increase in tonnage and decline in value are partly due to the reduction of pay-limit following the decline in working costs from 27s. 3d. per ton milled in 1929 to 25s. 8d. per ton in 1930. It is estimated that mill-bin renovations to be completed during the current year will bring the capacity of the treatment plant over 560,000 tons a year.

Modderfontein Deep Levels.—This company also belongs to the Union Corporation group and was formed in 1899 to work gold mining property in the Far East Rand. The report for the year 1930 shows that 664,723 tons of ore was mined and, after sorting 133,973 tons as waste, 530,750 tons was sent to the mill, where 275,252 oz. gold was recovered, the total revenue being £1,171,031. Working costs amounted to £419,600 and the working profit to £751,431. Dividends paid during the year absorbed £650,000, equal to 130%. The ore reserves at the end of 1930 were estimated to be 2,050,000 tons, averaging 8·6 dwt. over a stoping width of 79 in., as against 2,550,000 tons, averaging 8·8 dwt. over 79 in., at the end of the previous year. Work on the N.A. 7, or 200 ft. leader, has proved very disappointing, but a small tonnage of payable ore has been found in the leader horizons near to the main body, while a further tonnage of good grade ore was opened up on the main body when splitting the unpayable zones.

Geduld Proprietory Mines.—This company belongs to the Union Corporation group and was formed in 1899 to work a gold mine on the Far East Rand, south of Modderfontein B. The report for the year 1930 shows that 1,235,313 tons of ore was mined and, after sorting 223,113 tons as waste, 1,012,200 tons was sent to the mill. The gold recovered totalled 322,883 oz., and the revenue amounted to £1,369,152. Working costs amounted to £827,866 and the working profit to £541,286. Dividends paid during the year absorbed £474,779, equal to 32½%. The ore reserves at the end of 1930 were estimated to be 6,000,000 tons, averaging 6·6 dwt. over a stoping width of 59 in., as compared with 5,900,000 tons, averaging 6·7 dwt. over 58 in., at the end of the previous year. In his remarks, the consulting engineer draws attention to the continued improvement in extraction results. The residues in 1922 contained 0·639 dwt., whereas in 1930 this value had been decreased to 0·294 dwt.

East Geduld Mines.—This company, also belonging to the Union Corporation group, was

formed in 1927 and is developing a gold property adjoining the Geduld Proprietory Mines. The report for the year 1930 shows that such progress was made during the year that the development programme was almost completed, the shaft having reached a depth of 2,101 ft. The erection of a reduction plant to treat 60,000 tons monthly is under way and it is expected to be ready toward the end of 1931. A considerable proportion of the development footage accomplished during the year was devoted to blocking out payable areas for stoping purposes and as a result of this work the ore reserves amounted to 3,900,000 tons, averaging 7·0 dwt. over a stoping width of 58 in.

Tweefontein Colliery.—This company was formed in 1907 and in 1918 it disposed of its properties in the Transvaal to Tweefontein United Collieries, the former company becoming a holding company only. The report for the year 1930 shows that in its own year ended September 30 last Tweefontein United Collieries sold 791,383 tons of coal, a decrease of 37,337 tons when compared with its previous year, although a slightly larger profit was made. The gross revenue of Tweefontein Colliery, Ltd., for the year under review was £17,813 and, after deducting charges amounting to £2,884, adding the balance of £37,380 brought in, and allowing for preference dividends, there was an available total of £37,309. Dividends absorbed £10,500, equal to 12½%, including a 2½% bonus, on the ordinary shares. The new plant at the Waterpan shaft of the United Collieries, which has a capacity of 500 tons per hour, is said to be giving complete satisfaction.

Nundydroog Mines.—This company, formed in 1880, belongs to the group of gold mines in the Kolar district of Southern India which are managed by John Taylor and Sons. The report for the year 1930 shows that 127,144 tons of current ore was treated, yielding 66,742 oz. gold. In addition, 10,695 tons of accumulated tailings was re-treated, yielding 10,695 oz. gold. Dismantling of part of the old mill also produced 1,166 oz. and 143 oz. were recovered from ore mined by the Ooregum Company—making a total of 78,746 oz. gold—1,374 oz. less than the total for 1929. The value of the gold produced was £333,785, against £341,392. Expenditure for the year amounted to £217,620, and the profit was £100,409, as compared with £108,081 in the previous year. The total dividend for the year was 2s. 6d. per share, equal to 25%. Working costs at 24s. 2d. per ton, showed an increase of 1s. 11d. per ton, due to unavoidable increased mining and ventilation costs. The strike troubles in April last, which caused a cessation of work for three weeks, seriously interfered with operations, although the production of gold was largely retrieved by increased returns during the latter part of the year. The ore reserves at the end of the year were estimated to be 302,827 tons, as compared with 265,595 tons at the end of 1929. The favourable developments in the lower levels of the mine have been continued during the year.

Tharsis Sulphur and Copper.—This company, formed in 1866, works pyritic deposits in the Huelva district of Spain, and has also metal works in this country. The report for the year 1930 shows that the position at the works was similar to the previous year, the imports of pyrites into the United Kingdom showing no improvement. The total shipments of ores from the mines showed a reduction of approximately 6% in comparison with 1929. The development at the mines, including the new (North) lode at Calañas, was very satisfactory. The net profit on the year's operations was £131,015, as compared with £182,739 in the previous year, and £24,878 was brought in, against £82,139. A dividend, equal to 10%, was paid, absorbing £125,000, and the balance of £30,893 was carried forward.

DIVIDENDS DECLARED

Anaconda Copper.—37½ cents.

Ayer Hitam Tin Dredging.—1½d., less tax, payable March 30.

Central Provinces Manganese.—2s., tax free, payable April 4.

Globe and Phoenix Gold.—1s., tax free, payable April 28.

Gopeng Consolidated.—4d., less tax, payable April 7.

Ooregum Gold.—Pref. 6d., less tax, payable April 29.

Rawang Concessions.—6d., less tax, payable March 27.

Shamva.—6·6d., less tax, payable April 1 (liquidation distribution).

Tekka.—3d., less tax, payable March 31.

Tharsis Sulphur and Copper.—4s., less tax, payable May 9.

Transvaal Gold Mining Estates.—9d., less tax, payable May 4.

Tronoh Mines.—1½d., less tax, payable March 31.

Tweefontein Colliery.—Pref. 4%; ord. 2s. and 6d. bonus, less tax, payable March 31.

Union Corporation.—2s., less tax.

NEW COMPANIES REGISTERED

Anglo American Holdings.—Registered as a private company. Nominal Capital: £1,000 in 1s. shares. Objects: To acquire properties in the States of Colorado and Wyoming, U.S.A., and mining and other rights. Directors: Capt. J. G. Cheney and M. Stuart. Office: 479, Mansion House Chambers, 20, Bucklersbury, E.C. 4.

Associated Oil Drillers and Refiners.—Registered as a private company March 19. Nominal Capital: £22,500 (20,000 £1 Ordinary and 50,000 1s. Deferred). Objects: To acquire oil-bearing lands in any part of the world. Office: Dashwood House, 69, Old Broad Street, E.C. 2.

International Diamonds.—Registered March 20. Nominal Capital: £150,000 (100,000 Seven and a-Half per Cent. Cumulative Preference and 50,000 Ordinary). Objects: To carry on the business of diamond merchants, dealers in or brokers for the sale or purchase of bullion, workers and finishers and polishers of gems, pearls and precious stones, etc. Directors: O. Oppenheimer, H. S. Johnson-Hall, J. Jolis, and R. M. J. Thal. Office: 1, St. Andrew Street, E.C.

Pelepah Tin Dredging, Ltd.—Registered March 9. Nominal Capital: £200,000 in 5s. shares. Objects: To adopt an agreement with Sungei Besi Mines, Ltd., to acquire lands and mining and other rights in the Federated or Unfederated Malay States, Siam, or Burma, the Straits Settlements, or elsewhere, to carry on all kinds of mining and exploration business. So long as the company holds any land or rights in the Federated or Unfederated Malay States or the Straits Settlements it shall at all times be and remain a British company.